

PARKING CALCULATIONS		
	EXISTING SITE (TOTAL)	PROPOSED PLAN (TOTAL)
UPPER PARKING LOT (STAFF / VISITOR)		
ADA-Accessible Spaces	4	7
Designated Staff Parking Spaces (DS)	103	92
Visitor / Short-Term Dropoff Spaces (V)	15	22
LOWER PARKING LOT (STAFF)		
ADA-Accessible Designated Staff Parking Space	2	1
ADA-Accessible Designated Dropoff Space (On Top)	0	1*
Designated Staff Parking Spaces (DS)	16	11
SOUTH PARKING LOTS (STUDENT)		
ADA-Accessible Spaces	0	2
Student Parking Spaces	144	141
NORTH-REAR PARKING (STAFF / VISITOR)		
F-Bldg North ADA-Accessible Designated Space (DS)	0	1
F-Bldg North ADA-Accessible Dropoff Space (Daycare)	0	1*
F-Bldg North Visitor / Dropoff Spaces (V)	4	4
F-Bldg South ADA-Accessible Dropoff Spaces (ISN)	0	1*
Designated Staff Parking Spaces (DS)	22	23
Maintenance Spaces (M)	20	20
PARKING TOTALS (NET COUNT)		
	330	324
* designated dropoffs not included in parking counts		
ON-STREET PARKING (Institute Road)		
	11	10

Proposed Bicycle Parking:
TOTAL: 120 Bikes

MAIN ENTRY (North Ave): 32 Racks (64 bikes)

MAIN ENTRY (Bike Path): 16 Racks (32 bikes)

ATHLETICS AREA: 12 Racks (24 bikes)

- KEY**
- Pole Light, 16' Mounting Height, Single Fixture (Vehicular)
 - Pole Light, 16' Mounting Height, Double Fixture (Vehicular)
 - Pole Light, 12' Mounting Height, Single Fixture (Pedestrian)
 - Ground-Mounted Uplight, Single Fixture (Flagpole Illumination)
 - Recessed Wall Light, Integrated in Concrete Seating Elements
 - Removable Bollard
 - Fixed Bollard
 - Electric Car-Charging Station
 - Guardrail, 42" height from walking surface
 - Handrail, 36" height from walking surface
 - Fencing, 42" height along perimeter of gravel wetlands

NO.	DESCRIPTION	DATE
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BURLINGTON
HIGH SCHOOL

OVERALL
LANDSCAPE
PLAN

JOB NO. 887
SCALE: 1"=40'
DRAWN BY: HL
DATE: 6/8/2020

L100



PROPOSED LOT COVERAGE AREA

DESCRIPTION	PROPOSED LOT COVERAGE
WALKWAYS	35,292 SF
DRIVES	87,887 SF
PARKING	106,130 SF
EXISTING BUILDINGS AND STRUCTURES TO REMAIN	111,179 SF
BUILDINGS NEW	36,419 SF
ATHLETIC FIELDS, ASPHALT WALKS, BUILDINGS	211,367 SF
	588,273 SF

TOTAL SITE AREA = 2,116,012 SF

PROPOSED LOT COVERAGE = 588,274 SF
LOT COVERAGE AREA(EXISTING) = (567,812 SF)

% OF PROPOSED LOT COVERAGE = 27.80%
% OF LOT COVERAGE(EXISTING) = (26.83%)

PROPOSED LOT COVERAGE SUMMARY(w/o E-Bldg)

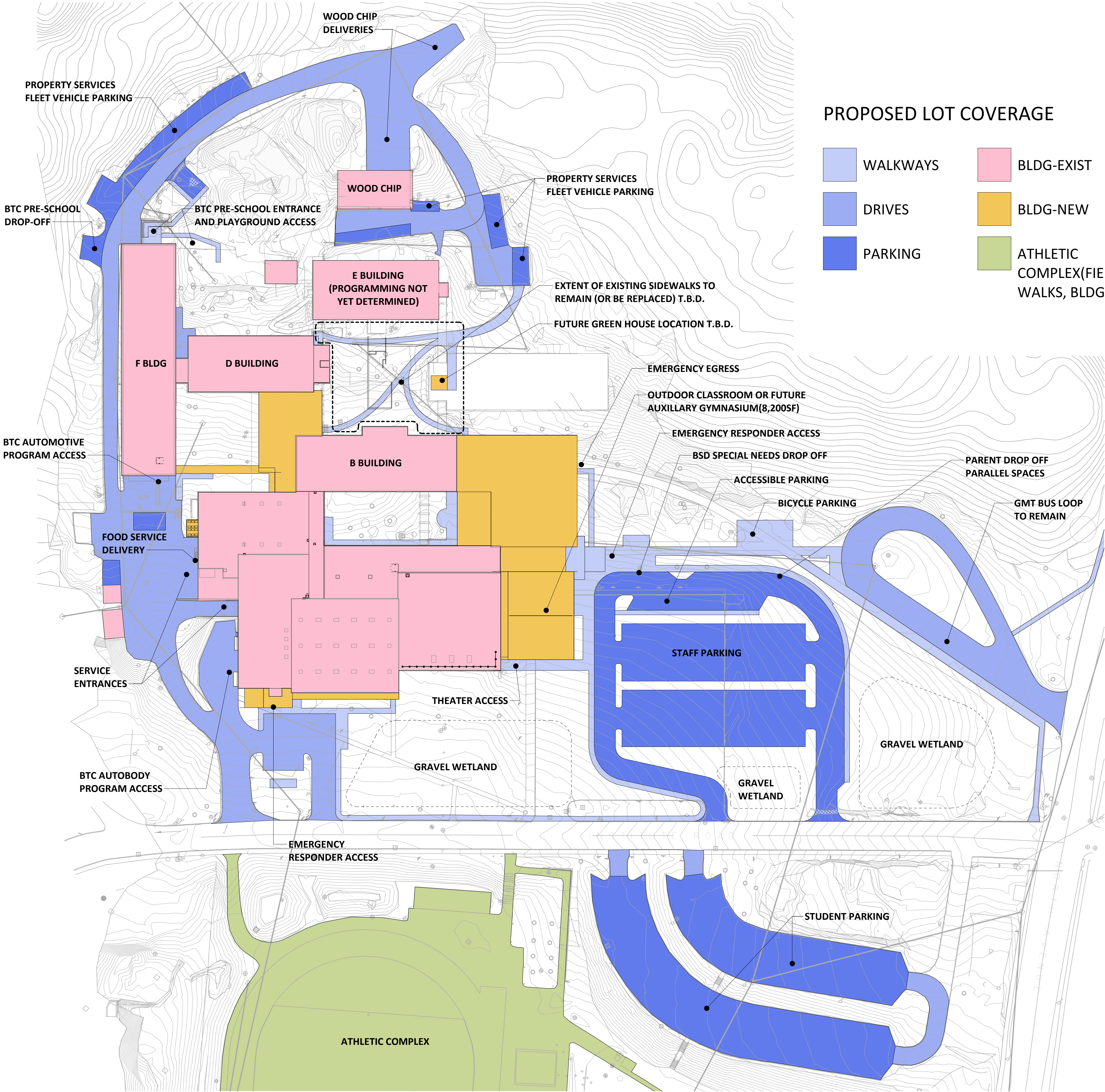
	Existing Area	Proposed Area	Existing Lot Coverage %	Proposed Lot Coverage %	% Change
Total Site	2,116,012 SF	2,116,012 SF			
Athletic Complex	211,365 SF	211,367 SF	9.99%	9.99%	0.00%
Bldg footprint	128,348 SF	137,982 SF	6.07%	6.52%	0.46%
Paving					
Walkways	31,753 SF	35,292 SF	1.50%	1.67%	0.17%
Drives	88,837 SF	87,887 SF	4.20%	4.15%	-0.04%
Parking	107,509 SF	106,130 SF	5.08%	5.02%	-0.07%
	567,812 SF	578,658 SF	26.83%	27.35%	0.51%
Parking Spaces (448 required by Zoning)	343	322*			

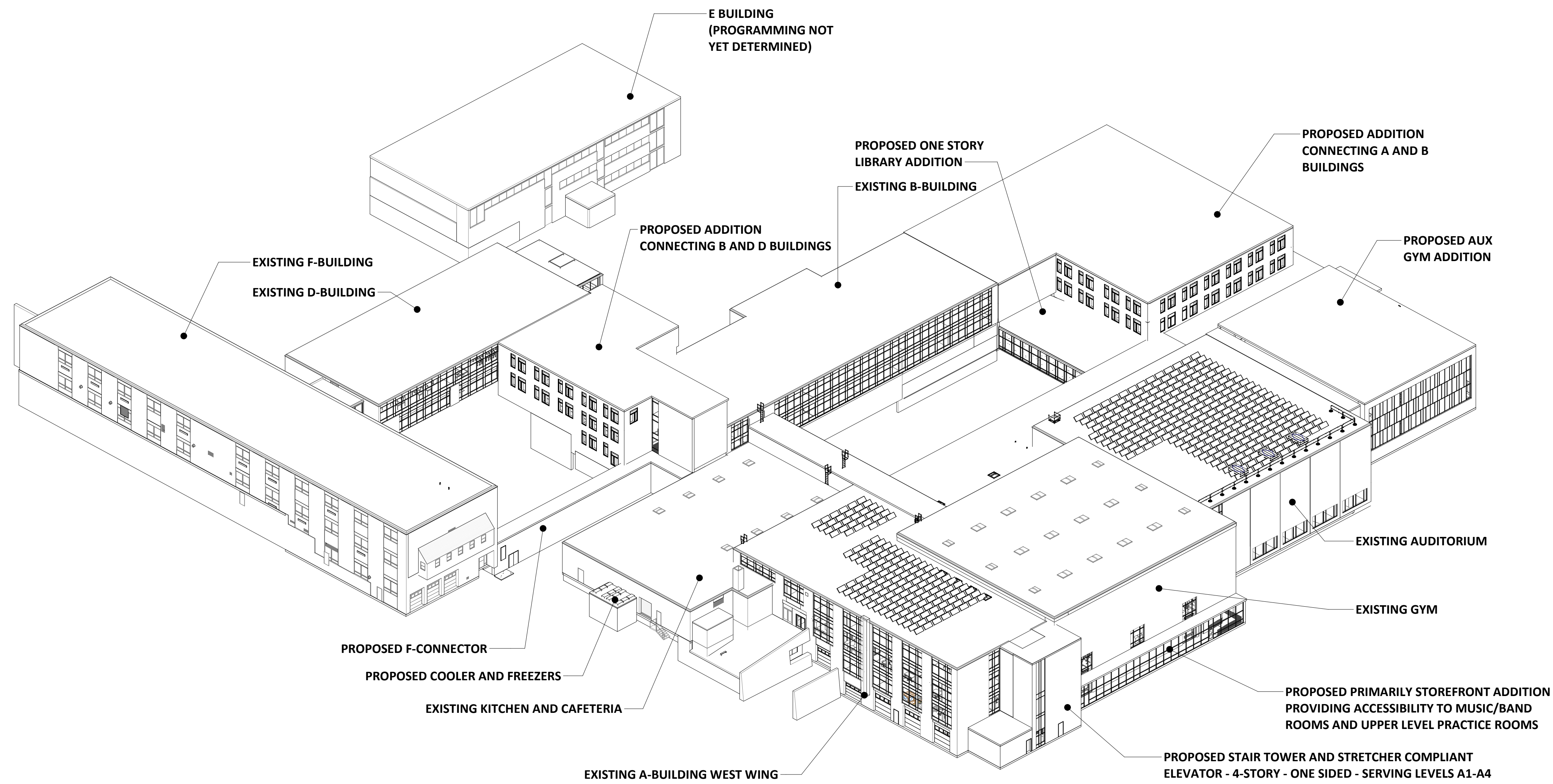
*REDUCTION OF +/- 70 SPACES FROM PROPOSED SD PLAN

PROPOSED LOT COVERAGE SUMMARY(with E-Bldg)

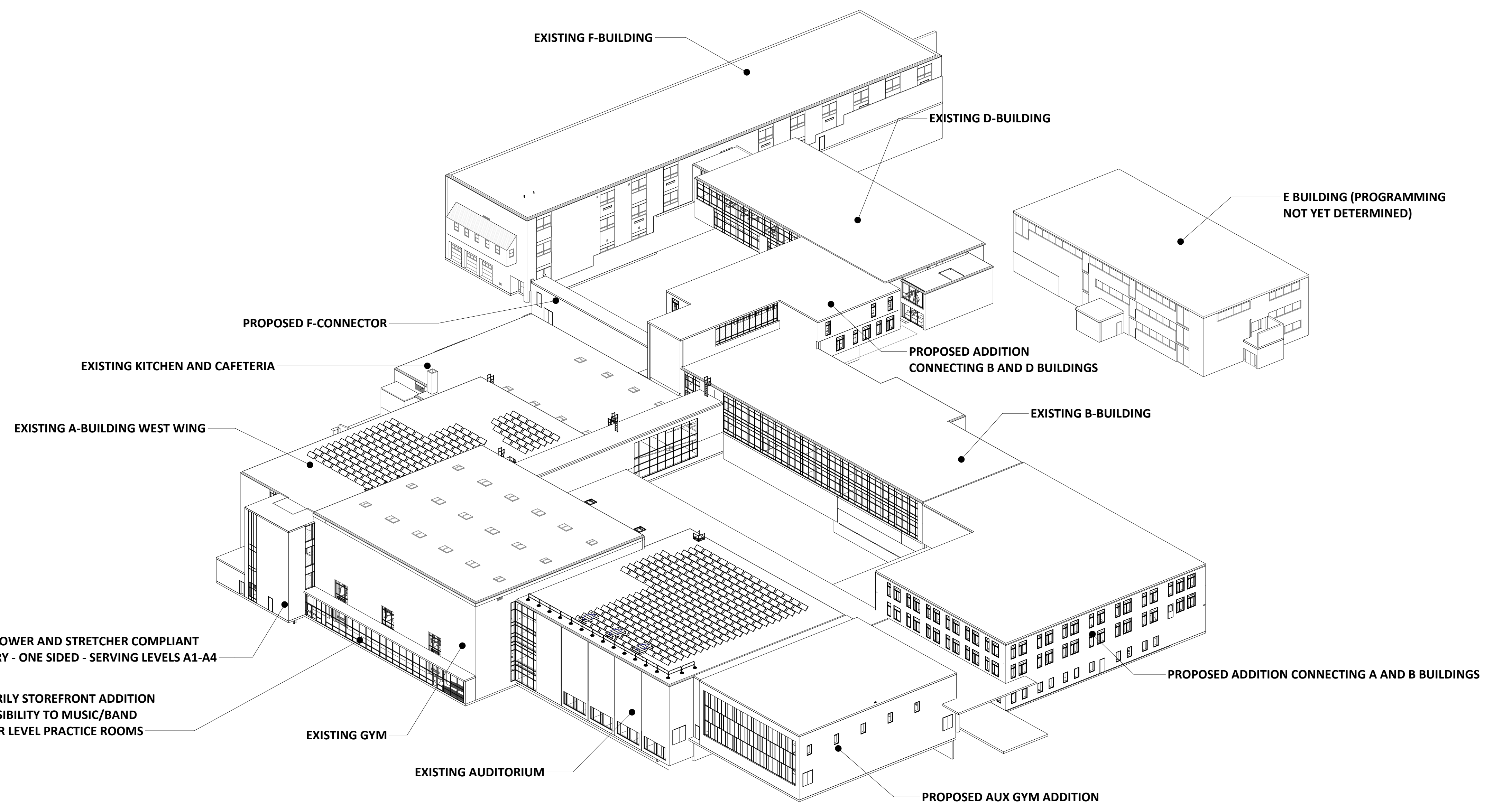
	Existing Area	Proposed Area	Existing Lot Coverage %	Proposed Lot Coverage %	% Change
Total Site	2,116,012 SF	2,116,012 SF			
Athletic Complex	211,365 SF	211,367 SF	9.99%	9.99%	0.00%
Bldg footprint	128,348 SF	147,598 SF	6.07%	6.98%	0.91%
Paving					
Walkways	31,753 SF	35,292 SF	1.50%	1.67%	0.17%
Drives	88,837 SF	87,887 SF	4.20%	4.15%	-0.04%
Parking	107,509 SF	106,130 SF	5.08%	5.02%	-0.07%
	567,812 SF	588,274 SF	26.83%	27.80%	0.97%
Parking Spaces (448 required by Zoning)	343	322*			

*REDUCTION OF +/- 70 SPACES FROM PROPOSED SD PLAN





VIEW LOOKING NORTH/EAST FROM WEST END OF INSTITUTE ROAD



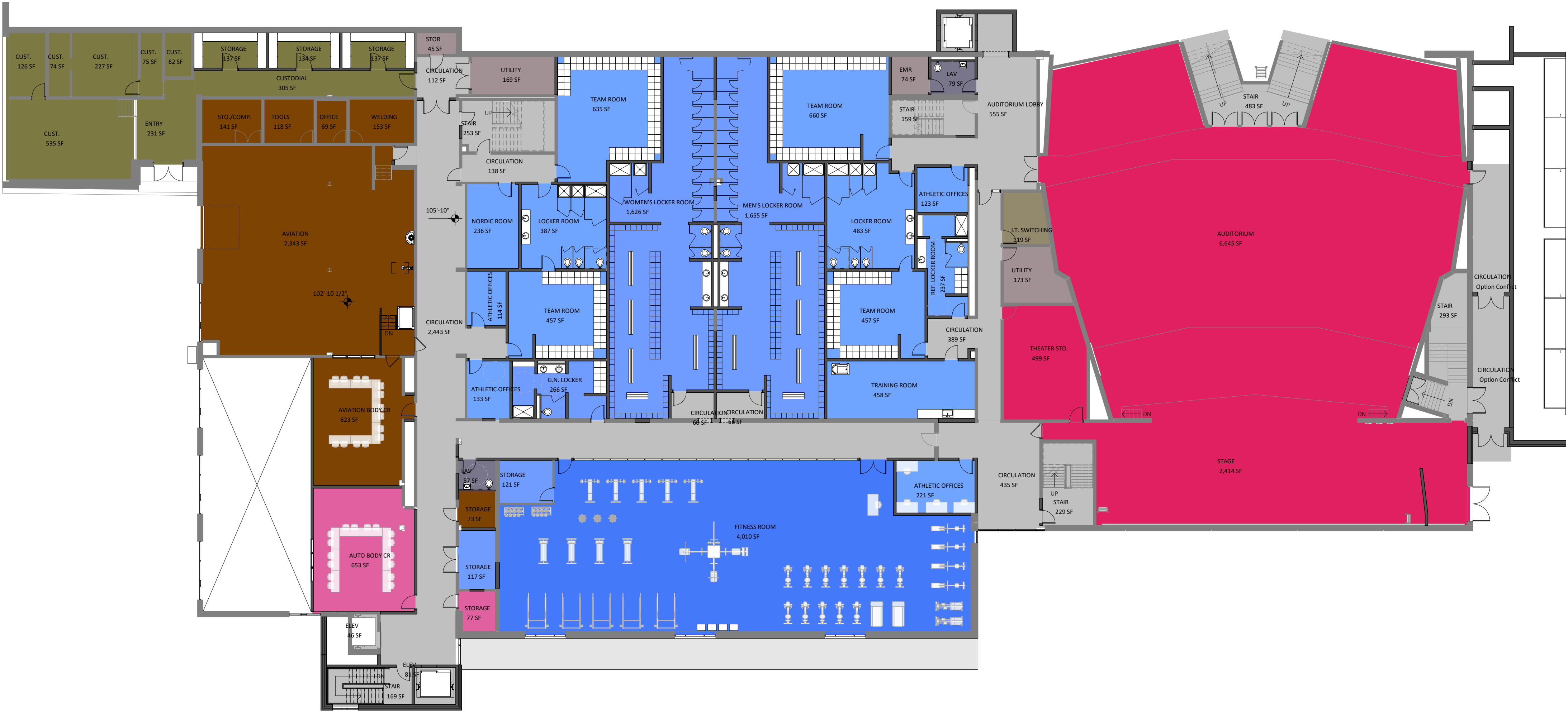
VIEW LOOKING NORTH WEST FROM NORTH AVE



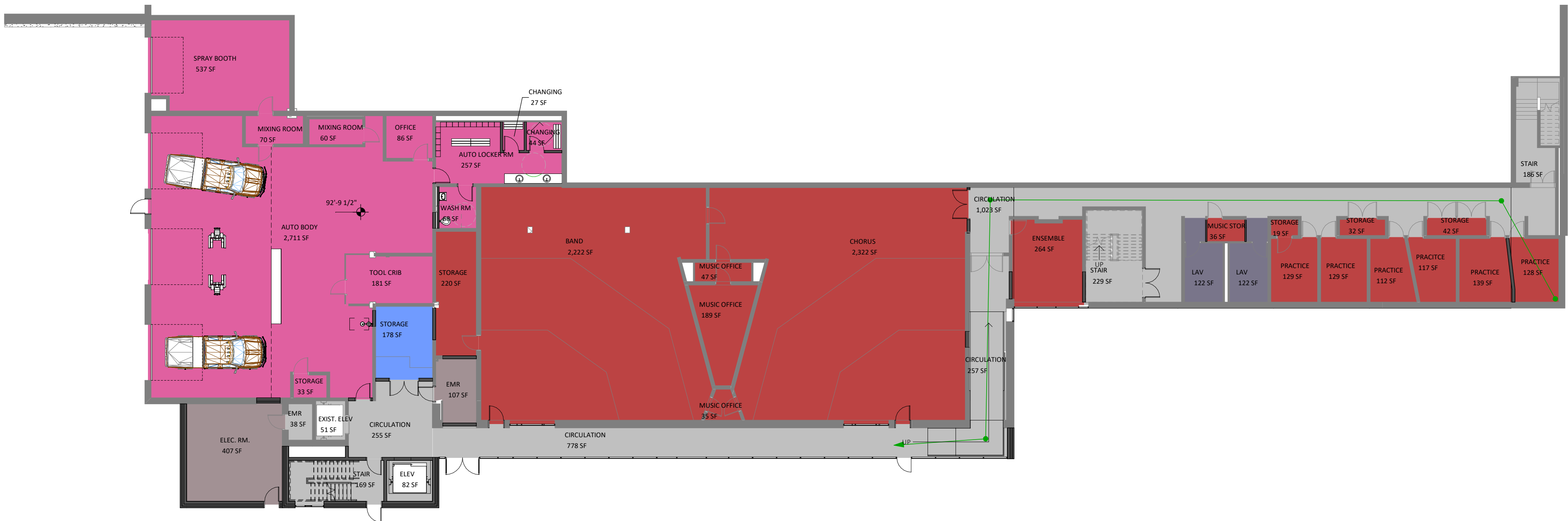
PROPOSED - 3D ORIENTATION PLAN

06/29/20 scale:

BURLINGTON HIGH SCHOOL RE-ENVISIONING



2 PROPOSED BUILDING A/B - LEVEL 2
SCALE: 1/16" = 1'-0"



1 PROPOSED BUILDING A/B - LEVEL 1
SCALE: 1/16" = 1'-0"

DEPARTMENT LEGEND

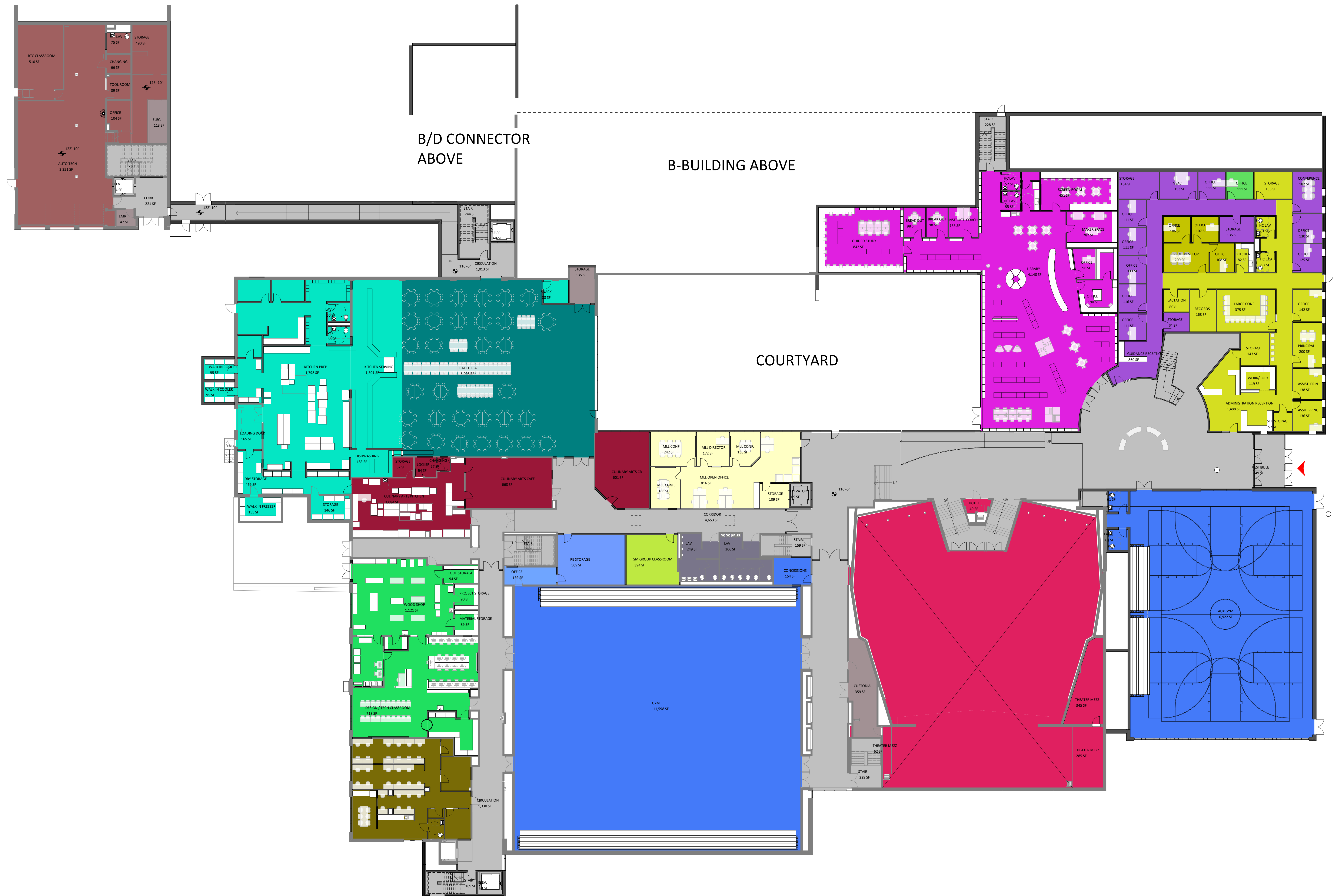
- ADMIN. - MLL
- ADMIN. - PROF. DEVEL
- ADMIN. GUIDANCE
- ADMIN. HEALTH
- ADMIN. STUDENT SERVICES
- ADMINISTRATION
- ATHLETICS
- ATHLETICS - PE
- ATHLETICS - SPORTS
- BTC
- BTC - ADMINISTRATION
- BTC - AUTO BODY REPAIR
- BTC - AUTO REPAIR
- BTC - AVIATION TECH
- BTC - COMPUTER PROGRAMMING & SCIENCES
- BTC - CRIMINAL JUSTICE
- BTC - CULINARY / PROFESSIONAL FOOD
- BTC - DESIGN & ILLUSTRATION
- BTC - DIGITAL MEDIA ARTS
- BTC - ENGLISH LANGUAGE
- BTC - HEALTH SCIENCES
- BTC - HUMAN DEVELOPMENT
- BTC - LEARNING LAB
- BTC - PRE TECH ENG., ARCH., & CONSTRUCTION
- BTC - WELDING & METAL FABRICATION
- CAFETERIA / KITCHEN - DINING
- CAFETERIA / KITCHEN - PREP
- CLASSROOM
- CLASSROOM - SHARED/CORE
- DESIGN & TECHNOLOGY
- DISTRICT ON TOP
- DRIVER'S ED
- FACULTY & SHARED RESOURCE SPACE
- FINE ARTS
- FOOD LAB
- I.T.
- INFRASTRUCTURE - CIRCULATION
- INFRASTRUCTURE - CUSTODIAL
- INFRASTRUCTURE - LAVATORY
- INFRASTRUCTURE - UTILITY
- LIBRARY
- MUSIC
- SCIENCE
- SP.ED.
- SP.ED. - INTENSIVE SPECIAL NEEDS
- THEATER - AUDITORIUM
- UNKNOWN



PROPOSED BUILDING A/B LEVEL 1 & 2 PLANS

2020-06-29 scale: 1/16" = 1'-0"

BURLINGTON HIGH SCHOOL RE-ENVISIONING



PROPOSED BUILDING A/B LEVEL 3 PLAN

2020-06-29 scale: 1/16" = 1'-0"

BURLINGTON HIGH SCHOOL RE-ENVISIONING



BURLINGTON HIGH SCHOOL RE-ENVISIONING



BURLINGTON HIGH SCHOOL RE-ENVISIONING



2 PROPOSED BUILDING F - LEVEL 2 PLAN
SCALE: 1/16" = 1'-0"



3 PROPOSED BUILDING F - LEVEL 3 PLAN
SCALE: 1/16" = 1'-0"



PROPOSED - BUILDING F/D LEVEL 2 & 3 PLANS

2020-06-29 scale: 1/16" = 1'-0"

BURLINGTON HIGH SCHOOL RE-ENVISIONING



AERIAL VIEW - NO GALLERIA NO GYM



AERIAL VIEW FROM SOUTH EAST



PROPOSED ENTRY VIEWS WITH/OUT AUXILIARY GYM

06/29/20 scale: 3" = 1'-0"

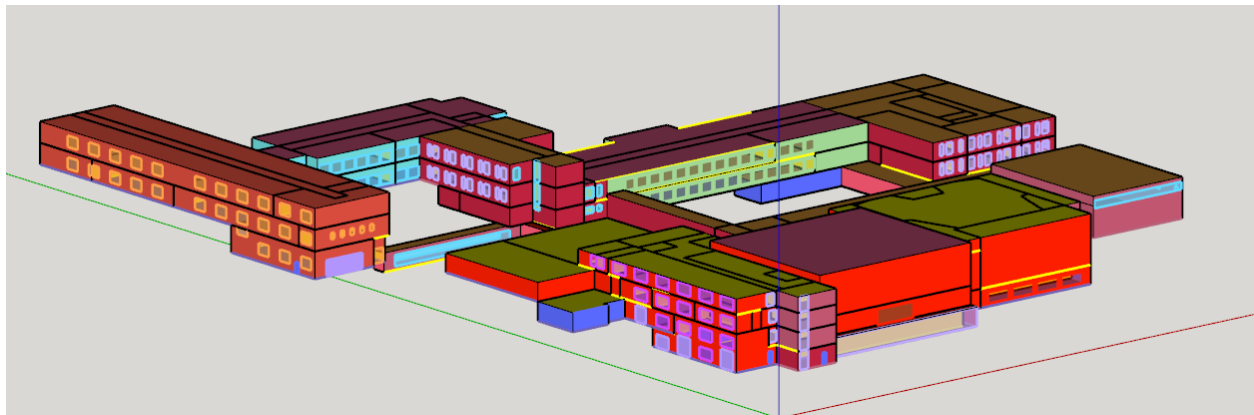
BURLINGTON HIGH SCHOOL RE-ENVISIONING

BLACK RIVER DESIGN ARCHITECTS

May 25, 2020
George Martin
LN Consulting

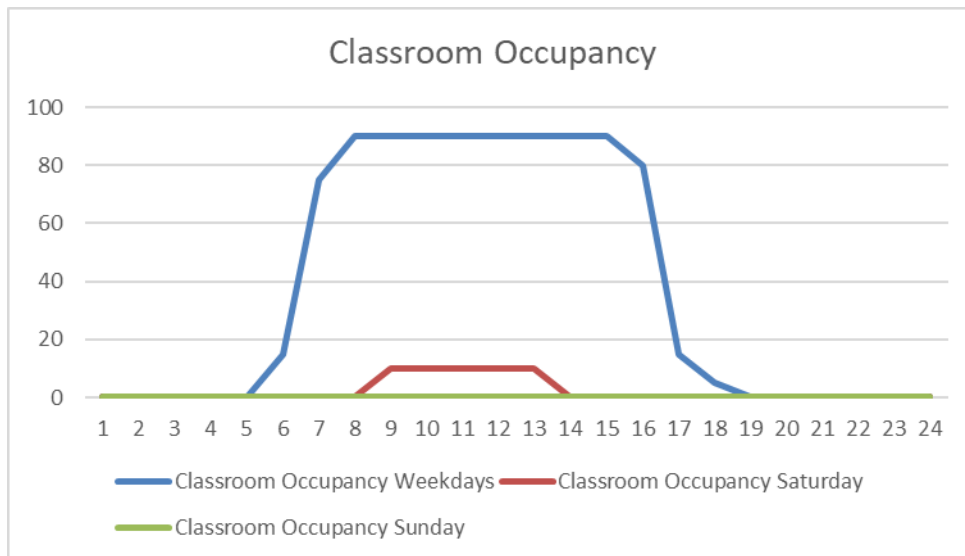
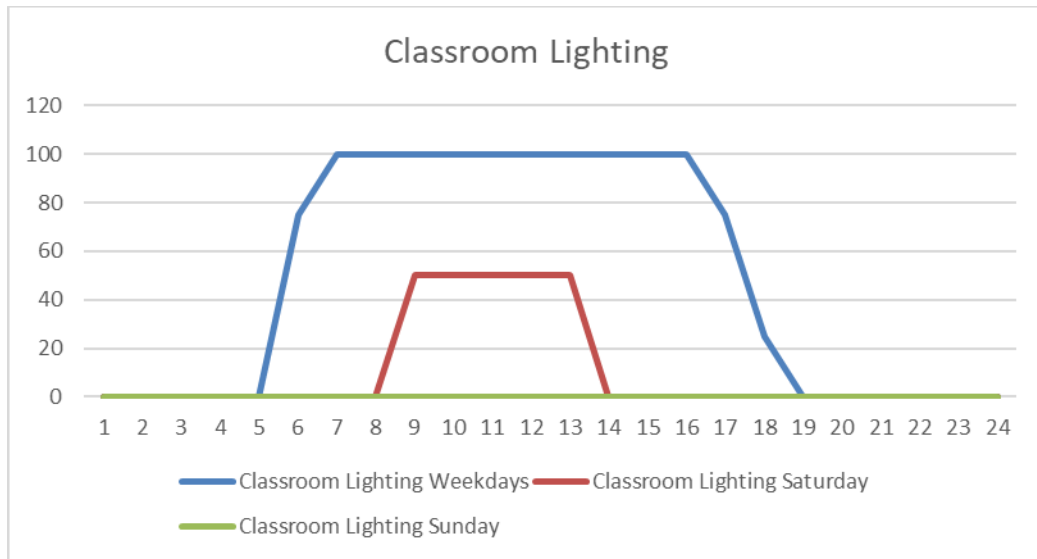
Burlington High School Energy Model Report

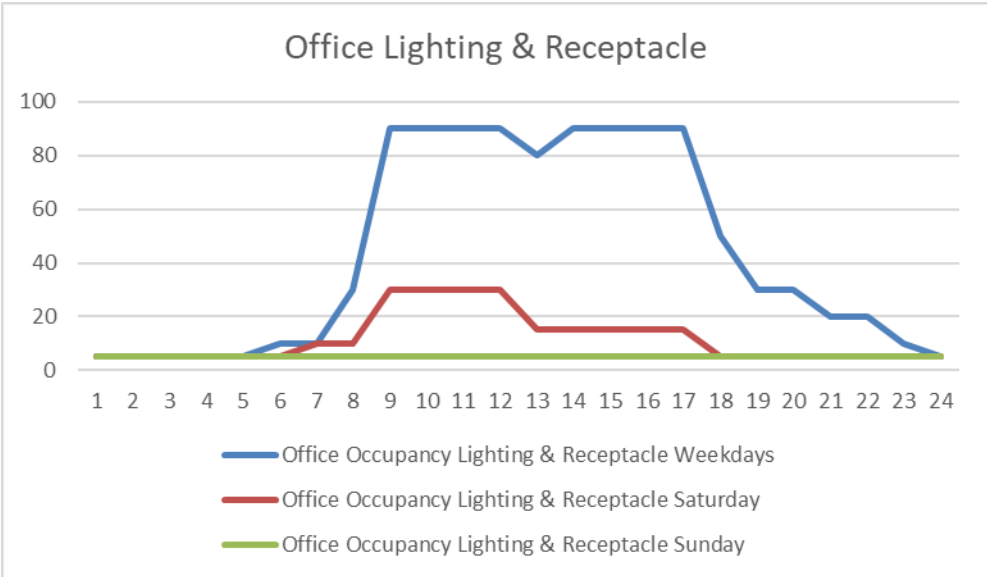
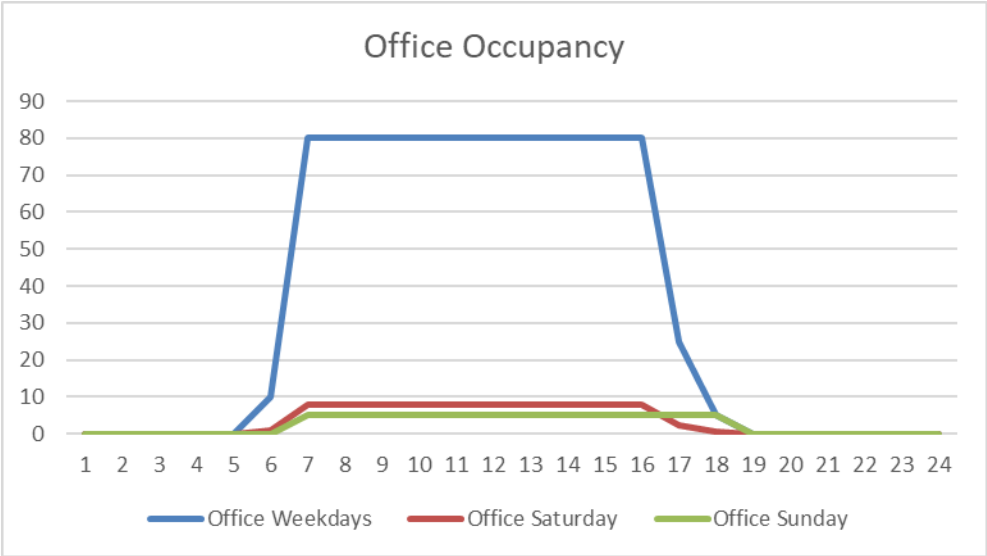
Second Law has completed an energy model of the Burlington High School proposed renovation and addition including updates to the building design. The building is about 280,000 square feet and includes classroom spaces, auditorium, gymnasium, library, kitchen, cafeteria and tech spaces. The energy model was created using EnergyPlus Version 9.1 software and is based on drawings and information provided to Second Law by Black River Design Architects and LN Consulting.

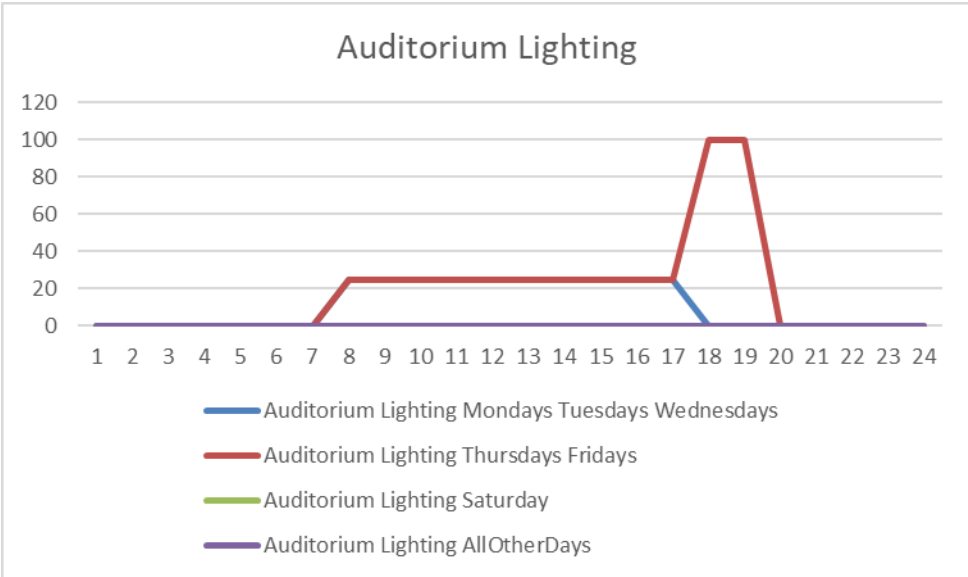
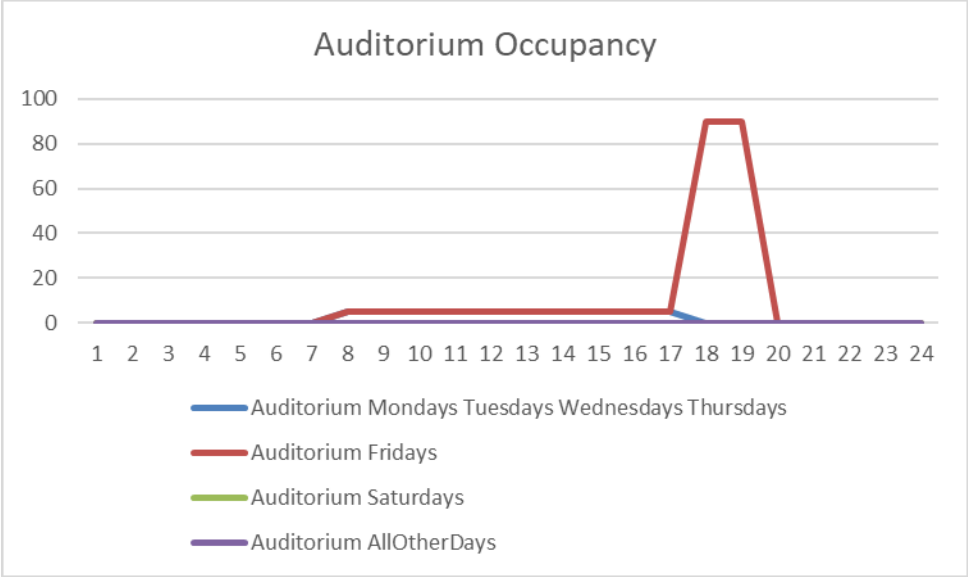


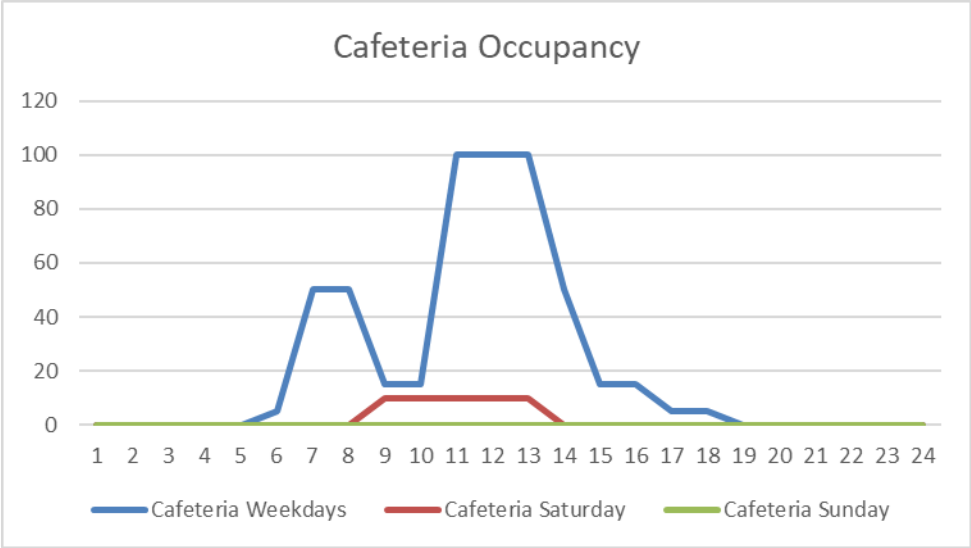
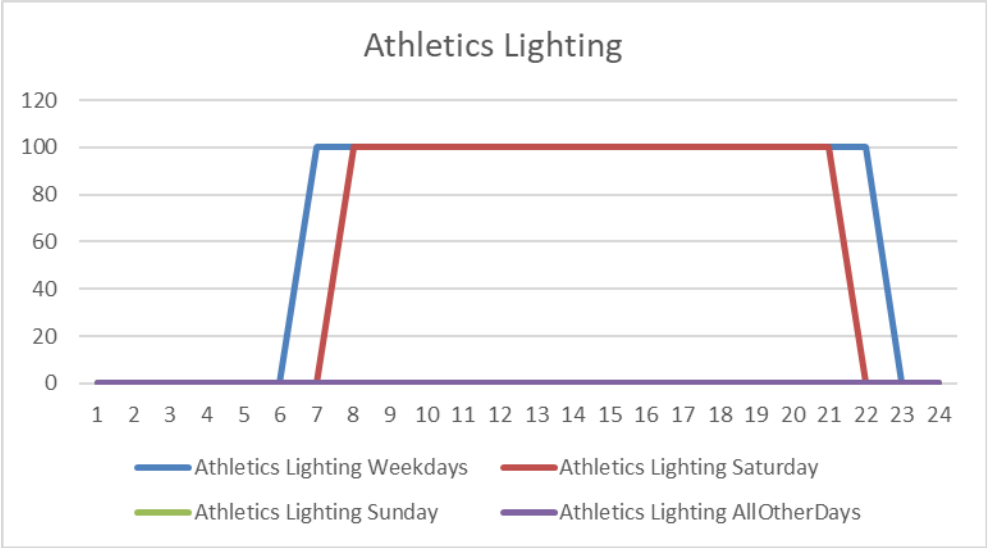
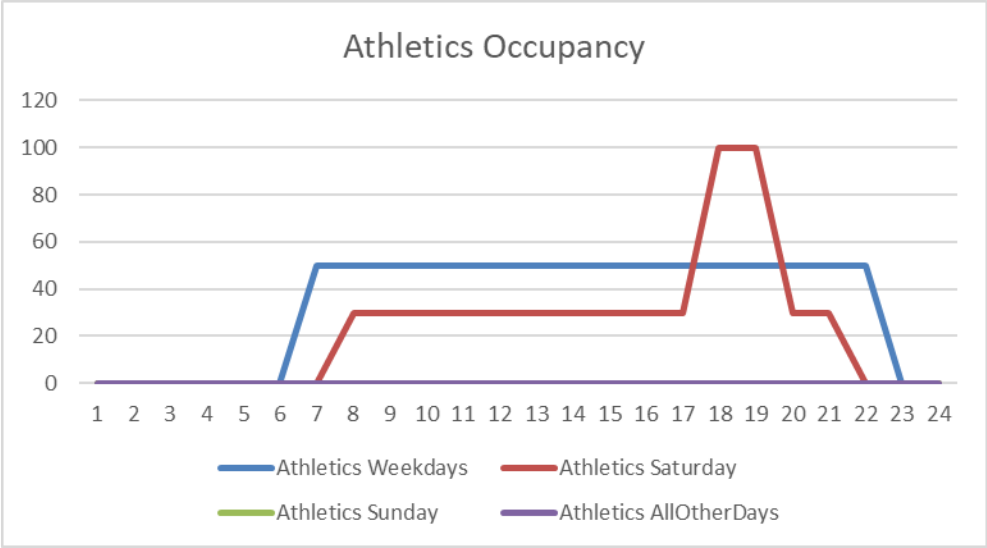
The following pages are a summary of inputs used in the creation of the energy model.

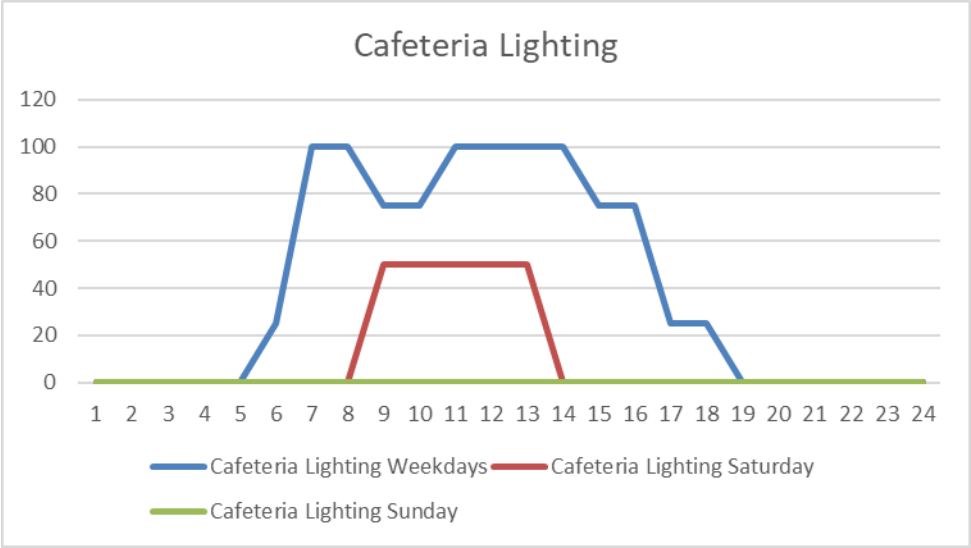
Schedules:











Envelope Components:

	existing construction	proposed upgrade	alternatives to model
A Building			
walls	masonry walls overall insulation value R-12.5	none	Review the existing exterior wall upgrades Option C and include as an alternate.
windows	Existing drawings show 1" insulated glass(double glazed) in a metal frame(not thermally broken)	Punched windows will be thermally broken aluminum , double glazed windows(glazing to match previously provided specifications)	
slab	shown uninsulated	none	
underground walls	3" rigid insul to 3' below grade	none	
B Building			
walls	masonry walls overall insulation value R-12.5	Scope currently includes NO improvements	Review the existing exterior wall upgrades Option C and include as an alternate.
windows	Existing drawings show 1" insulated glass(double glazed) in a metal frame(not thermally broken)	Punched windows will be thermally broken aluminum , double glazed windows(glazing to match previously provided specifications)	
slab	uninsulated	none	
underground walls	3" rigid insul to 3' below grade		
D Building			
walls	Existing drawings show 3" rigid insulation	Scope currently includes NO improvements	Review the existing exterior wall upgrades Option C and include as an alternate.
windows	Existing drawings show 1" insulated glass(double glazed) in a metal frame(not thermally broken)	Punched windows will be thermally broken aluminum , double glazed windows(glazing to match previously provided specifications)	
slab	shown uninsulated		
underground walls	3" rigid insul to 3' below grade		
F Building			
wall A & B	masonry walls overall insulation value R-12.5	F-Bldg improvements are not included in the project scope	
windows	Existing drawings show 1" insulated glass(double glazed) in a metal frame(not thermally broken)	F-Bldg improvements are not included in the project scope	
slab	shown uninsulated	F-Bldg improvements are not included in the project scope	
underground walls	3" rigid insul to 3' below grade	F-Bldg improvements are not included in the project scope	
Roofs			
R-1(A-bldg)	6" foam board (R-30)	R-40	
R-2(A-bldg)	4" styrofoam (R-15)	R-40	
R-3(A-bldg)	4" styrofoam (R-15)	R-40	
R-4(A-bldg)	4" styrofoam (R-15)	R-40	
R-5(A-bldg)	4" styrofoam (R-15)	R-40	
R-7(B-bldg)	6" foam board (R-30)	R-40	
R-10(D-bldg)	6" foam board (R-30)	R-40	

Infiltration – 0.04166999992755 cfm/ ft2 exterior area

Proposed Constructions:

Exterior Walls:

R-25

Roofs:

R-40

Fixed Glazing:

U – 0.29

SHGC – 0.4

Operable Glazing:

U – 0.37

SHGC – 0.4

Infiltration – 0.019685 cfm/ ft² exterior area

Internal Loads:

People:

	Area / Person
Athletics People	103.5
Auditorium People	21.96
Auto & Aviation People	89.04
Cafeteria People	9.98
Classroom1 People	89.34
Classroom2 People	89.34
Conference People	49.91
Corridor People	998.24
Culinary People	111.3
District On Top People	156.72
Kitchen People	49.91
Library People	156.72
Office People	179.68

Lighting:

	Proposed W/sf	Baseline w/sf
Auditorium_LPD	0.5	0.63
Classroom_LPD	0.8	1.24
Corridor_LPD	0.53	0.66
GYM_LPD	0.65	1.11
Office_LPD	0.5	0.81

Electric Equipment:

	W/sf
Athletic Equip	0.25
Auditorium Equip	0.1
Auto & Aviation Equip	1
Cafeteria Equip	0.25
Classroom Equip	0.5
Classroom2 Equip	0.5
Conference Equip	0.75
Culinary Equip	2
District on Top Equip	0.5
Kitchen Equip	3.01
Library Equip	0.5
Mech Equip	1
Office Equip	0.75

HVAC Alternatives:

1. Fossil Fuel Baseline – this model includes the baseline system as specified by ASHRAE 90.1. It includes a central air handling unit for each floor with cooling provided by central chilled water coils and heating provided by hot water coils located in the air handling unit and reheat coils in each zone. The system includes energy recovery ventilation, demand control ventilation and economizers where required by code. The heating plant is supported by a fossil fuel boiler.
2. Rooftop Unit BED Baseline – this system is the baseline required for BED incentives if the AHU system is chosen for design. It includes air handlers as in #4, but with minimal efficiencies and operation.
3. WSHP BED Baseline – this system is the baseline required by BED for electrical incentives if a WSHP system is chosen for the design. It includes a water source heat pump system as in #5, but with minimal efficiencies and operation.
4. Rooftop Unit Proposed – this system consists of a rooftop units equipped with DX cooling coils and hot water heating coils. Supply air is varied between 55 and 60F to meet the cooling setpoint of the warmest zone. Air handlers have economizer capabilities, demand control ventilation and energy recovery.
5. Water Source Heat Pump System Proposed– this system models a central ventilation unit for each floor. The ventilation units include energy recovery ventilators. Ventilation uses CO2 sensors located in each space to vary the amount of ventilation air based on occupant density. Space heating and cooling is provided by water source heat pumps.

The water source heat pump loop is maintained between 70 and 90F by a cooling tower and hot water is provided by the central heating plant.

The central plant includes a natural gas boiler which operates from May 15 through October 10 and a wood chip boiler which operates from October 10 – May 15.

6. Two speed water source heat pump system – The model is similar to #5 but with the higher efficiency two speed/modulating heat pumps and higher efficiency Energy Recovery Units.

HVAC Alternatives Results:

Electricity: \$0.14/kWh

Natural Gas: \$0.95/ccf

Wood Chips: \$60.00/Ton

1. Fossil Fuel Baseline –
Electrical: 1,105,877 kWh - \$154,822.78
Natural Gas (Heating): 186,429 CCF - \$177,278.73
Wood Chips (Heating): N/A
Total Utility Cost per year: **\$332,101.51**
Carbon Emissions (Metric Tons per year): 952*
2. Rooftop Unit BED Baseline –
Electrical: 661,259 kWh - \$136,336.76
Natural Gas (Heating): 134,181 CCF - \$127,594.66
Wood Chips (Heating): N/A
Total Utility Cost per year: **\$220,170.92**
Carbon Emissions (Metric Tons per year): 685*
3. WSHP BED Baseline –
Electrical: 741,842 kWh - \$103,857.88
Natural Gas (Heating): 67,568.96 CCF - \$64,252.47
Wood Chips (Heating): N/A
Total Utility Cost per year: **\$168,110.35**
Carbon Emissions (Metric Tons per year): 345*
4. Rooftop Unit Proposed –
Electrical: 254,412 kWh - \$35,617.68
Natural Gas (Heating): 3,322 CCF - \$3,046.65
Wood Chips (Heating): 48,964 Tons - \$34,562.82
Total Utility Cost per year: **\$73,227.15**
Carbon Emissions (Metric Tons per year): 17 *
5. WSHP Proposed –
Electrical: 374,199 kWh - \$52,387.86
Natural Gas (Heating): 171 CCF - \$156.75
Wood Chips (Heating): 31,835 Tons - \$22,471.76
Total Utility Cost per year: **\$75,016.37**
Carbon Emissions (Metric Tons per year): 0.87*
6. Two Speed WSHP Proposed
Electrical: 225,442 kWh - \$31,561.88
Natural Gas (Heating): 212 CCF - \$194.75
Wood Chips (Heating): 34,791 Tons - \$24,558.35
Total Utility Cost per year: **\$56,314.98**
Carbon Emissions (Metric Tons per year): 1.1*

*Carbon emissions assume all wood chips are sustainably sourced to allow for net carbon neutral operation

BHS Energy Model Results
Electricity
Natural Gas
Wood Chips

0.14 kwh
0.95 ccf
\$60 ton
85 Therm/Ton

	Fossil Fuel Baseline			Rooftop Unit BED Baseline			WSHP BED Baseline			Rooftop Unit Proposed			WSHP Proposed			WSHP (High Efficiency)		
	Electricity (kwh)	Natural Gas	Wood Chips	Electricity (kwh)	Natural Gas	Wood Chips	Electricity (kwh)	Natural Gas	Wood Chips	Electricity (kwh)	Natural Gas	Wood Chips	Electricity (kwh)	Natural Gas	Wood Chips	Electricity (kwh)	Natural Gas	Wood Chips
Heating		179,951			0	129,518		331,792	65,221		0	3,207	169,148	165	31,835	98,737	205	34,791
Cooling	331,445			411,759			140,120			125,054		48,964	90,709			72,292		
Interior Lighting	722,120			722,120			722,120			472,347			472,347			472,347		
Interior Equipment	312,575	208		312,575	208		312,575	208		312,575	208		312,575	208		312,575	208	
Fans	535,831			240,560			233,978			124,682			94,019			50,326		
Pumps	236,391			8,940			35,626			4,676			19,925			3,686		
Heat Rejection	2,210						326						398			401		
Water Systems		7,033				7,033		7,033			5,923			5,923			5,923	
TOTAL	2,140,572	187,192	0	1,695,954	136,759	0	1,776,537	72,462	0	1,039,334	9,338	48,964	1,159,121	6,296	31,835	1,010,364	6,336	34,791
	\$299,680.08	\$184,412.20	\$0.00	\$237,433.56	\$134,728.13	\$0.00	\$248,715.18	\$71,385.94	\$0.00	\$145,506.76	\$8,871.10	\$34,562.82	\$162,276.94	\$5,981.20	\$22,471.76	\$141,450.96	\$6,019.20	\$24,558.35
Total	\$484,092.28			\$372,161.69			\$320,101.12			\$188,940.68			\$190,729.90			\$172,028.51		

Total HVAC System Cost Estimate \$12,871,591.00 \$13,371,591.00 \$14,471,591.00

Rooftop Unit System Total \$188,940.68
WSHP Total \$190,729.90
Difference -\$1,789.22

Note the RTU option may requior additional roof structural improvements that have yet to be identified.



February 05, 2020

Mark Montminy
Black River Design Architects
73 Main Street, Room 9
Montpelier, VT 05602

Burlington High School Renovation/Addition Project–Mechanical, Plumbing, Electrical & Fire Protection February 2020 SD Cost Estimate Heating Only Cost Reduction

L.N. Consulting, Inc. has been retained to provide a Schematic Design narrative for the proposed renovations to the Burlington High School. The existing campus consists of (6) buildings; A-building, B-building, C-building, D-building, E-building and the F-building which is the Burlington Technical Center (BTC). The C building will be demolished as part of the current design plan. The proposed project consists of a complete renovation of the existing D-building; a renovation and addition to the main A-building and the existing B-building; and a partial renovation of the BTC F-building. The A-building is (4) levels; the lower (2) levels of the building are partial floors. The B-building is currently (2) levels and will have a lower level added as part of the project. The lower level of the B-building will be at the same level as Level 3 of the A-building. The BTC F-building is (3) levels; the lowest level is a partial floor which is at the same level as the lower level of the B-building and Level 3 of the A-building. A new connector will be installed between the B-building and D-building connecting the lower level of D-building with the upper level of B-building. The current architectural drawings indicate the proposed program will include the following:

A-Building:

- | | |
|----------|---|
| Level 1: | Spray Booth, Auto Body Shop, Mixing Rooms, Auto Locker & Changing Rooms, Tool Cribbs, Band Room, Chorus Room, Ensemble Room, Practice Rooms |
| Level 2: | Property Services offices/breakroom and storage areas, Aviation Room and Welding and Tool Room, Electrical Service Entrance, Aviation Body, multiple Team Rooms, Men's & Women's Locker Rooms, Team Locker Rooms, Training Room, Fitness Room, Athletic Offices, Auditorium Stage (and lower level of Auditorium) |
| Level 3: | Main building entrance with Atrium and lobby area, entrance to the Auditorium, main kitchen and auxiliary offices/storage, Cafeteria and supporting spaces, loading dock, Culinary Arts spaces, Culinary Arts Classroom, Culinary Arts Café, Main/Large Gymnasium, PE Storage, Guidance offices, Health offices, Wood Shop and supporting spaces, Design/Tech and supporting spaces, BTC Faculty rooms, Multi-Lavatory Spaces, New Auxiliary Gymnasium with (2) supporting Lavatories |



Level 4: Art Rooms, ISN Program space, Main IT Offices and IT Servers, Upper level atrium space (walkway to Level 1 of B-building), MLL Offices, Existing Mechanical Room

B-building:

Level 0: Library, Maker Space, Screen Room, Library Offices, Guided Study, Administration Offices

Level 1: Professional Development Offices, Classrooms, ISS Offices, SLP Offices and Sped Testing rooms

Level 2: Classrooms, Faculty Lounge, DOT Classrooms, DOT Reception, DOT Kitchen

L2 Connector to D: Classrooms, Corridor/Ramp

L3 Connector to D: Classrooms, Corridor/Ramp

D-building:

Level 1: (3) Science Classrooms, (2) Science Prep rooms

Level 2: (4) Science Classrooms, (2) Science Prep rooms, Food Lab

F-Building (Tech Center):

Level 1: BTC Classroom, Auto Tech, Auto Tech supporting storage spaces, Toilet/Shower area

Level 2: Sound/Recording, Audio Rooms, Digital Media Classrooms, Design and ILL Lab, Metals/Welding and support spaces, Metals/Shop and support spaces, Maker Space and support space, Welding Classroom

Level 3: Health Sciences Offices, BTC Staff Room, BTC Conference Room, Health Sciences Classrooms, Computer Lab, Work Based Learning Lab, BTC Classrooms, Forensics Lab, English Language Classrooms, Preschool space

1. Outdoor Design Conditions

Elevation	200	ft.
Winter		
Dry bulb	-11	F

Summer		
Dry bulb	84	F
Wet bulb	69	F
Relative Humidity	47	RH
Dew Point	62	F
Moisture	82	grains/lbs.

2. Indoor Conditions

Thermostat/Sensor set points. Space humidity levels will be continuously monitored via thermostats and sensors located throughout the facility. During the cooling season, the humidity levels will be controlled by the ventilation units which will be sequenced to sub-cool and then reheat (via modulating hot gas reheat) the air to reduce the space humidity levels. Additional moisture will also be removed from each space via the air-source heat pumps where those systems are located (see Space Conditioning section below). The space humidity levels will be monitored, but not controlled during heating mode.

General Classroom/Office Space Temperature/RH Control Schedules

	Winter Occupied	Winter Unoccupied	Summer Occupied	Summer Unoccupied
Temperature	72 F	66 F	75 F	82 F
RH %	Uncontrolled	Uncontrolled	<50%	<50%

General Shop Space Temperature/RH Control Schedules

	Winter Occupied	Winter Unoccupied	Summer Occupied	Summer Unoccupied
Temperature	70 F	60 F	75 F	84 F
RH %	Uncontrolled	Uncontrolled	<50%	<50%

General Back of House Spaces Temperature/RH Control Schedules

	Winter Occupied	Winter Unoccupied	Summer Occupied	Summer Unoccupied
Temperature	70 F	60 F	76 F	84 F
RH %	Uncontrolled	Uncontrolled	<50%	<50%

3. Ventilation Design – The ventilation rates supplied to each space within the renovated building will be calculated based on the procedures outlined in ASHRAE 62.1-2016. Ventilation air will generally be provided by dedicated rooftop heat recovery and energy recovery ventilators for all spaces except for the Science Labs (D-building), Gymnasium and Auditorium spaces



(these spaces will have integral energy and heat recovery sections). The kitchen make-up air will be mostly supplied by rooftop Make-up Air Units (MAUs) and supplemented by the Cafeteria ERV.

Existing

4. Mechanical-Building Conditioning

Currently the Burlington High School campus including the Burlington Tech Center (BTC) F-building are conditioned by a hot water hydronic system that supplies hot water to terminal units throughout the campus. The water is heated either by the main biomass boiler plant during the winter, or by the gas fired backup boiler(s) during the shoulder seasons. Water is distributed to heat exchangers located in each building via rooftop mounted hot water piping. This piping is insulated and jacketed, but we understand that there are numerous locations where the insulation is in poor condition or missing. We also understand that the piping has routinely leaked and has required regular repairs.

Each building has dedicated heating hot water circulators that distribute the water to the terminal heating units. The majority of the buildings are conditioned by exterior wall mounted unit ventilators. The unit ventilators provide ventilation air to the space by pulling in outdoor air through an exterior louver. Air is relieved through the roof from gravity relief hoods or exhausted through the roof by exhaust fans. Heating for the unit ventilators is provided by the central heating hot water system.

The gymnasium is conditioned by (4) large air handling units installed in the vertical located high up on the walls of the gym. The air handling units bring in outdoor air through intake hoods located on the roof. We understand that the gravity reliefs have been plugged and are no longer functional. This causes the air handling units to pressurize the space which is evidenced by noticeably strong air movement at the entrance doors into the gymnasium. The lack of relief for the space is likely limiting the amount of ventilation air being brought into the gymnasium. The gymnasium air handling units are also original to the building and have reached the end of their useful service life.

The shop spaces in the A-building were conditioned by direct gas-fired make-up air units. Direct combustion air handling units discharge the products of combustion into the space. This is not recommended for environmental air quality reasons.

The kitchen exhaust fan is a down blast type unit which discharges the kitchen exhaust down towards the roof. The existing make-up air unit is currently located too close to this exhaust fan and the kitchen exhaust is often recirculated back into the cafeteria/kitchen. This condition needs to be rectified. We recommend replacement of both units as part of this project. See recommendation in the proposed section below.

The Auditorium has a relatively new air handling unit which is located in the Level 4 mechanical room adjacent to the Auditorium. This unit provides cooling for the Auditorium by utilizing a remote Direct Expansion (DX) compressor/condensing unit located on the roof with refrigerant lines piped to the cooling coil in the unit. A hot gas reheat coil in the unit enables the unit to dehumidify the discharge air to allow the unit to reduce the humidity in the space without overcooling the space. A hot water heating coil in the unit provides the necessary heating capabilities for the space. The unit has an energy recovery wheel to pre-condition the incoming



outdoor ventilation air to save energy. This unit is controlled by the building Direct Digital Controls (DDC) system.

A new energy recovery unit with an energy recovery wheel is located in the Level 4 mechanical room adjacent to the Auditorium. The unit provides ventilation air to the locker rooms on the lower level along with some surrounding spaces. The unit has heating and cooling capabilities to post condition the ventilation air (after the air is pre-conditioned by the energy recovery wheel) to a neutral air temperature for distribution to the spaces. The cooling for this unit is provided by a remote Direct Expansion (DX) compressor/condensing unit located on the roof with refrigerant lines piped to the cooling coil in the unit. A hot gas reheat coil in the unit enables the unit to dehumidify the discharge air to allow the unit to reduce the humidity in the space without the need to overcool the air. A hot water heating coil in the unit provides the necessary heating capabilities for the ventilation air. This unit is controlled by the building Direct Digital Controls (DDC) system.

The BTC F-building shops are conditioned similar to the shops in the A-building. They have space mounted gas fired make-up air units with exhaust fans located in a small mechanical room located on the upper level of the building. It is our understanding that the positively pressurized exhaust ductwork downstream of the exhaust fans is not well sealed. This causes dust, dirt, and odors from the welding and auto shops to leak into the room. We do not recommend having pressurized ductwork (ductwork downstream of the fan) inside the building for exhaust systems that handle noxious air.

The classrooms in the BTC F-building are generally conditioned by hot water unit ventilators. However, some of the unit ventilators in the F-building have cooling capabilities. A refrigerant cooling coil is installed in the unit ventilators with cooling capabilities. The refrigerant piping is connected to a compressor/condensing unit located on the roof. Many of the unit ventilators are not equipped with cooling and some of those spaces have had large window mounted air conditioners installed for cooling. A few locations, including the Criminal Justice classroom were observed to have window air conditioners cut into the glass windows to provide cooling for the spaces. These units are left in place year round which causes an increase in infiltration of unconditioned outdoor air.

Proposed

5. Mechanical-Building Conditioning

General

The existing HVAC infrastructure for the facility is old and is not configured for the proposed facility expansion, nor is it configured to provide cooling to the entire facility. Because of the age of the facility and the extensive renovations planned, we recommend removing the existing HVAC system, with the exception of the newer A-building Auditorium AHU and the newer ERV unit currently serving the locker rooms in the A-building.

The existing Biomass heating plant will remain to serve as the primary heating source during the winter. The existing natural gas fired heating plant building which currently serves as a shoulder season heating source and backup heating source will be reused. The existing equipment (including pumps, boilers, expansion tanks, piping etc.) will be demolished and all new pumps, boilers specialties etc. will be installed within the gas fired heating plant building. The existing



pump(s) for the central plant will be replaced and the existing piping will be reconfigured as necessary to accommodate the new primary-secondary pumping system outlined below along with the heat-add loops for the natural gas fired boilers and the biomass heating plant in their respective buildings. For phasing, the existing natural gas-fired backup boilers will be utilized to heat the E-building which we understand will be utilized as swing space during construction. This equipment will be demolished with the E-building at a future date To Be Determined by Burlington School District.

Space Conditioning

The primary means of building conditioning shall be via a hydronic hot water system. Generally, heating shall be provided by hydronic fintube radiation and/or hot air using hydronic unit heaters, hot water fan coil units, or duct mounted reheat coils.

Typical Classroom

The individual classroom spaces and non-administrative office spaces will be conditioned by fintube. Preliminary equipment selection is for the fintube to be equivalent to Runtal R2F-4 which will be installed along the exterior envelope walls in each space. Each typical classroom or office (non-administrative space) will be a dedicated heating zone with the heating controlled by a modulating 2-way control valve that modulates to maintain space temperature.

Typical Shops

Shop spaces will be conditioned by hydronic unit heaters equivalent to Modine HC's. The shop unit heaters will be sized for 50 Btu/hr./sq.ft. and will be oversized approximately 30% above nominal ratings to account for the derating factor of the lower water temperatures. Each shop will have dedicated temperature control.

Typical Science Classroom

The D-building science classrooms will be conditioned using a rooftop air handling unit (with heat recovery) and a Variable Air Volume (VAV) system with modulating duct mounted reheat coils. See AHU-1D in the Air Handling unit section below.

Typical Office/Administrative Area and Meeting Space

Offices and administrative areas will be conditioned by an Air-to-Air heat pump Variable Refrigerant Flow (VRF) system using ducted fan coil units with backup heating hot water duct mounted reheat coils. A modulating 2-way valve (controlled by the DDC system) shall control the water through the reheat coils to maintain space temperature when the outdoor air temperature is below set point. The VRF systems will be equivalent to Daikin VRV IV Heat Recovery that is to be capable of simultaneous heating and cooling capabilities and operation down to -13°F. The indoor ducted fan coil units (located above the ceiling) will be equivalent to Daikin FXSQxxTAVJU. The VRF system is to have full BACnet integration for set point control, fan speed control, and unit monitoring from the building BMS. Each heating/cooling zone is to contain a local space mounted temperature sensor to control unit operation. See below for preliminary VRF systems and sizing:

- A-Building:
 - System #1 to be an 18-ton VRF Located on the Roof: Serving Fitness Room 4105, Faculty 1141 and 1142
 - System #2 to be a 6-ton VRF Located on the Roof: Serving Facilities Suite 2027, 2028, 2029, 2030, Kitchen Staff Offices.

- System #3 to be a 16-ton VRF Located on the Roof: Serving I.T. Suite, I.S.N. Suite, Small Group CR 4049, Health Suite, BTC Offices, Culinary Arts Café, Culinary Arts Classroom 1316
- System #4 to be 3-ton Cooling only VRF equivalent to Daikin FTXS36LVJU/RKS36LVJU for the I.T. Server Room. The outdoor unit is to be located within the Level 4 Mechanical Room.
- B-Building:
 - System #1 to be a 16-ton VRF Located on the Roof: Serving Faculty 1091, Eastern Lower Level Administrative Office Suite
 - System #2 to be a 14-ton VRF Located on the Roof: Offices 1324-1326, Conference 1327, SLP & SPED Rooms 1172, 1336, 1337, 1150, Lower Level Library and Western Administrative Office Suite
 - System #3 to be a 6-ton VRF Located on the Roof: ISS Office Suite, Professional Development Office Suite
- F-Building:
 - System #1 to be a 6-ton VRF Located on the Roof: Health Sciences and BTC Staff, Design/ILL Lab, Computer Lab F343, F344, F345
 - System #2 to be a 6-ton VRF Located on the Roof: Serving Preschool Suite

Typical Gymnasium

Gymnasiums shall be conditioned and ventilated by roof mounted Air Handling Units (AHU's) with an integral ERV section and economizer cooling capabilities. See specific unit sizing information in the AHU section below.

Auditorium

The Auditorium unit shall remain as currently operating with a remote condensing unit and heating hot water coil for space conditioning.

Cafeteria

The Cafeteria shall be conditioned by a rooftop fully recirculating AHU (see additional information below) with 100% economizer capabilities.

Paint Spray Booth

The paint Spray Booth located on the lower level of the A-building will be heated by a natural gas fired unit heater equivalent to the Sterling Nexus condensing style unit heater rated for 50,000 Btu/hr.

Rooftop Air Handling Units

The rooftop units will be installed on 18" insulated roof curbs. The air handling units will be utilized for the (2) gymnasiums and the cafeteria. These units will be equivalent to Aaon RN series with integral air-source heat pump to provide both cooling and heating. The gymnasium units will be provided with an integral Semco energy recovery wheel; the cafeteria unit will be fully recirculating with 100% economizer capability. The gymnasium energy recovery units will have will total energy recovery wheels which have the ability to transmit both sensible and latent (moisture) energy between the incoming outdoor ventilation air and the outgoing exhaust air. This significantly reduces the energy necessary to condition the ventilation air. The air handling



units shall utilize an air-source heat pump to condition the supply air distributed to the space. A hot water heating coil with modulating 2-way valve and balance valve will be installed for backup heating capabilities. The units will have fully ducted supply and return systems. In the gymnasiums, a return fan (equivalent to Greenheck QEID) is to be located high in the space (suspended from the structure with vibration isolators) ducted to the return connection to the unit. The air should be returned through an expanded metal opening on the top of the return ductwork (upstream of the fan). CO2 sensors shall be located throughout the space to modulate the ventilation air as necessary to maintain space CO2 levels below set point. The units will have EC fan motors where applicable or premium efficiency motors with VFDs where EC motors are not available. The refrigeration equipment will have modulating compressors, modulating hot gas reheat for dehumidification, variable speed condenser fans with EC motors and head pressure controls, dedicated return fan and modulating recirculation dampers. The hot water piping through the roof will be fully insulated and jacketed and will have heat trace in the piping to prevent the water from freezing. All (3) units are to have the ability of providing 1.5" of external static pressure on the supply and return fans. The return air and outdoor air streams will have 2" MERV 8 pre-filters to protect the coils and the energy recovery wheel. The units will have 4" MERV 13 final filters. The units will have 100% economizer capabilities including bypass dampers around the energy wheel. Ebtron Gold airflow stations will be installed on the supply air and return air duct mains, in the outdoor air intake plenum, and in the exhaust air plenum. The units will also have outdoor air and exhaust air isolation dampers at the exterior of the units.

The refrigeration systems for the units will have modulating compressors. The unit will also be provided with modulating hot gas reheat capabilities. The refrigeration system is to have factory controls to modulate the compressors and the hot gas reheat as necessary to maintain the discharge air temperature set point as determined by the DDC system. The (3) air handling units are indicated below with preliminary sizing:

AHU-1A Serving the Large Gymnasium (11,600 sq.ft): This unit will be rated to deliver 17,500 Cubic Feet per Minute (CFM) of supply and return air to the gymnasium. The ventilation section will be rated for 11,750 CFM. This unit will have supply and return duct smoke detectors as well as smoke dampers, equal to Ruskin SD-60 with flanged frame and linkage as required with 24VAC actuators and UL listed for smoke control. The unit will be controlled to maintain space temperature and humidity and the ventilation rate will be controlled to maintain space Carbon Dioxide (CO2) levels below set point values. Main duct size out of the unit to be 60/28.

AHU-2A Serving the Auxiliary Gymnasium (6,935 sq. ft): This unit will be rated to deliver 10,500 Cubic Feet per Minute (CFM) of supply and return air to the gymnasium. The ventilation section will be rated for 4,400 CFM. This unit will have a supply duct smoke detector. The unit will be controlled to maintain space temperature and humidity and the ventilation rate will be controlled to maintain space Carbon Dioxide (CO2) levels below set point values. Main duct size out of the unit to be 50/22.

AHU-3A Serving the Cafeteria (6,030 sq. ft): This unit will be rated to deliver 9,250 Cubic Feet per Minute (CFM) of supply and return air to the cafeteria/kitchen space. The ventilation air delivered from the Cafeteria ERV (see ventilation section) section will be rated for 5,350 CFM. This unit will have a supply duct smoke detector. The unit will be controlled to maintain space temperature and humidity at set point values. Main duct size out of the unit to be 46/20.



AHU-4A Existing Auditorium Unit (8,700 sq.ft.): This existing unit will remain serving the auditorium space. The current unit has a hot water coil and split system Direct Expansion (DX) cooling system with a rooftop condensing unit which is to remain. The existing Auditorium ductwork will need to be modified as necessary to accommodate the new Roof Smoke Vents that will be installed above the stage.

AHU-1D D-Building Unit (16,500 sq.ft): This unit will be rated for 23,000 CFM and will have both supply and return duct detectors and Ruskin SD-60 smoke dampers with flanged frame and linkage as required with 24VAC actuators and UL listed for smoke control. This unit will be 100% outdoor/exhaust air (like the HRV's indicated below). The unit will be a Mainstream with a heating hot water coil and refrigeration coils, both DX and hot gas reheat. The refrigeration coils are to be connected to a rooftop mount Aeon heat pump condensing unit. The Aeon remote condensing unit heat pump will have modulating compressors, modulating EC condenser coil fan motors with head pressure control, sound reduction package including compressor blankets and cabinet insulation, and factory refrigeration controls. The refrigeration piping will be field installed between the (2) units. The Aeon will be mounted on structural steel with housed spring isolators. The exhaust section of the unit including the plate heat exchanger and exhaust fan will be epoxy coated to prevent corrosion and unit deterioration. The unit exhaust will be discharged straight up rather than out the side for dispersion. Exhaust ductwork serving the science labs and preparation areas will be fully welded stainless steel. It is currently assumed that there will be **(3)** fume hoods total. The fume hoods will be modulating flow hoods with integral modulating controls and air velocity sensors to adjust a duct mounted control valve equivalent to TSI model EL-316-FLA-S/S. Bubble tight dampers, equivalent to Ruskin BTO92 will be installed in the ductwork to ensure that the room exhaust air ductwork is isolated from the fume hood exhaust if the exhaust fan(s) in the AHU fail. Supply and exhaust air duct mains will be located on the roof of the D-building due to lack of ceiling space with vertical shafts down to the levels below. Roof mounted ductwork to be installed within a "dog house" under the roof envelope. Main duct size out of the unit to be 60/30. The airflow will be controlled via Variable Air Volume (VAV) boxes and the unit supply and exhaust fans will operate as a variable volume unit to maintain a duct static pressure set point. Discharge supply air will be conditioned by a air-source heat pump sized to provide space conditioning air during the summer, and the hot water heating coil. The unit will be controlled to maintain the lowest required discharge temperature to satisfy all zones served by the unit as well as reduce humidity using the modulating hot gas reheat control. Individual zones space temperatures will be controlled by VAV boxes with reheat coils.

The kitchen hoods will be new and sized to meet the requirements of the cooking equipment located underneath them. The hoods will be rated for Type 1 or Type 2 exhaust based on the equipment they are exhausting. The exhaust hoods will have variable volume controls with temperature and smoke sensors, and will have an Ansul fire suppression system. Hoods will have UL listed isolation control dampers. Roof mounted exhaust fans connected to each hood will be installed on 18" insulated roof curbs with hinges to provide for duct access and cleaning. The fans will have either EC motors or high efficiency motors with Variable Frequency Drives (VFDs) and the fan speed will be modulated by the variable volume hood controls. Preliminary estimates are for main kitchen total exhaust flow to be 5,100 CFM. The Culinary Arts Kitchen preliminary estimate is for the total flow to be 4,000 CFM. The hoods will have supply plenums at the front for the make-up air duct connections so that make-up air is delivered directly at the hoods.



MAU-1 Serving the Main Kitchen: This space will be normally conditioned by the heating hot water fan coil units equivalent to Envirotec HPP. Type 1 and/or Type 2 kitchen hoods equivalent to the hoods mentioned above for the main kitchen will be installed over the cooking equipment in this space that requires exhaust. Roof mounted upblast exhaust fan(s) will be installed on roof curbs and controlled by the variable volume hood controls systems. A roof mounted air-source heat pump with natural gas fired backup make-up air unit MAU-1 will be installed to provide the make-up air needed directly to the front of the hoods to match the exhaust from the kitchen hoods minus 1,000 CFM. The make-up air unit will be equal to a Captiveaire CASRTU3 with a modulating EC supply fan, modulating air-source heat pump with modulating hot gas reheat, modulating EC condenser fans, an 18" insulated roof curb, supply duct smoke detector installed in the supply ductwork, factory installed controls and a modulating gas fired burner. The operation of this unit will be by the factory hood controls to maintain discharge air temperature using either the air-source heat pump or the gas fired heater. Preliminary sizing is for the unit to flow 4,100 CFM. Main duct size out of the unit to be 24/20.

MAU-2 Serving the Culinary Arts: This space will be normally conditioned by the heating hot water fan coil units equivalent to Envirotec HPP. Type 1 and/or Type 2 kitchen hoods equivalent to the hoods mentioned above for the main kitchen will be installed over the cooking equipment in this space that requires exhaust. Roof mounted upblast exhaust fan(s) will be installed on roof curbs and controlled by the variable volume hood controls systems. A roof mounted air-source heat pump with natural gas fired backup make-up air unit MAU-2 will be installed to provide the make-up air needed directly to the front of the hoods to match the exhaust from the kitchen hoods. The make-up air unit will be equal to a Captiveaire CASRTU3 with a modulating EC supply fan, modulating air-source heat pump with modulating hot gas reheat, modulating EC condenser fans, an 18" insulated roof curb, supply duct smoke detector installed in the supply ductwork, factory installed controls and a modulating gas fired burner. The operation of this unit will be by the factory hood controls to maintain discharge air temperature using either the air-source heat pump or the gas fired heater. Preliminary sizing is for the unit to flow 3,000 CFM. Main duct size out of the unit to be 22/18.

Building Ventilation

All of the spaces that are not conditioned by rooftop air handling units will have their ventilation air supplied by either Energy Recover Ventilators (ERVs) or Heat Recovery Ventilators (HRVs). The ERV's and HRV's will be dedicated ventilation units that are 100% outdoor air and 100% exhaust air (no air is recirculated). All ERVs except ERV-2A will be equivalent to Aaon RN units. The HRVs will be equivalent to Mainstream (see AHU-1D above) with a plate heat exchanger core and an Aaon remote condensing unit for cooling/dehumidification. The ERVs will utilize a total energy recovery Semco wheel to recover both sensible and latent (moisture) energy from the outgoing exhaust air stream to the incoming outdoor air. All ERV's will have an integral air-to-air heat pump with modulating compressors, modulating hot gas reheat, heating hot water coil, exhaust air and outdoor air isolation dampers, VFD wheel speed control and energy recovery wheel bypass dampers. The HRVs will have refrigeration coils (see AHU-1D) for both DX heating/cooling, hot gas reheat coil, heating hot water coil, heat recovery core bypass dampers, and exhaust air and outdoor air isolation dampers. The Aaon remote condensing unit heat pump will have modulating compressors, modulating EC condenser coil fan motors with head pressure control, sound reduction package including compressor blankets and cabinet insulation, and factory refrigeration controls. The refrigeration piping will be field installed between the (2) units. The Aaon will be mounted on structural steel with housed spring isolators. ERV-2A serving will be equivalent to Petra APPH with a heating hot water coil. The ERV will utilize a high efficiency Sorption Coated dual heat exchanger core (AccuBloc). The



unit will have an integral air cooled compressor/condenser with variable speed compressors and condensers and modulating hot gas reheat control. All units will have MERV 8 pre-filters and MERV 13 final filters. All units will have EC fans with modulating speed capabilities where applicable. The fan speed will be modulated to maintain a static pressure set point in the ductwork which will vary based on the ventilation requirements in each individual zone. The units will be provided with supply duct smoke detectors. The units that flow greater than 15,000 CFM are to also have return air duct smoke detectors and smoke dampers equivalent to Ruskin SD-60 with flanged frame and linkage as required with 24VAC actuators and UL listed for smoke control. The outdoor air supply ductwork will be insulated with 1" of 1.5 PCF duct wrap (for ductwork smaller than 24" wide) or 1" of 3 PCF duct board insulation (for ductwork 24" or larger wide).

The ventilation air will be distributed throughout the facility with ductwork. Each ventilation zone will have an outdoor air supply and exhaust air Variable Air Volume (VAV) boxes. These boxes independently measure the air going through each box and can modulate a damper to maintain a desired airflow set point. There will be (2) types of ventilation zones. There will be constant volume ventilation zones such as zones that serve restrooms and janitor's closets, and there will be variable volume zones for the balance of the building. The variable volume ventilation zones will modulate the ventilation air delivered to and exhausted from each space to ensure that no space exceeds CO2 set point levels. By reducing ventilation air to the spaces that do not need design flow, significant energy is saved by both not conditioning and not moving the excess air. Each classroom, conference room, lab, and large work area will have dedicated zones (1 supply and 1 exhaust VAV each). Multiple office spaces will be combined into a single ventilation zone with ventilation air distributed to each office with a fully ducted supply and exhaust system. CO2 will be monitored in every office space and the VAV boxes will modulate as necessary to ensure no office exceeds CO2 set points. Preliminary estimates are that (1) ventilation zone will encompass approximately (5) adjacent office spaces. The supply VAV's will generally discharge the supply air into the return plenums of the ducted heat pump fan coil units.

ERV-2A (see below) is to provide ventilation air to the Main Kitchen and the Culinary Arts Kitchen. The VAV boxes are to provide the additional 1,000 CFM make-up air (exhaust air minus the MAU make-up air) via transfer from the Cafeteria and Culinary Arts Café spaces respectively. Ventilation air to the Cafeteria to be provided by Ruskin CD-60 dampers with Ebtron ELF airflow stations (combination units to operate as a variable volume box).

There are multiple rooms within the facility that will contain equipment requiring localized exhaust. The Library Maker's Space, Autobody, Welding, Pre-Tech, Design Tech Spray Booth, Art Pottery Studio, Art Metals, Aviation Welding, Custodial Closets, Printer Areas (Work Areas) all will have local exhaust inlets to capture fumes. Where applicable Monkey Arm flexible exhaust arms or capture hoods will be utilized to provide exhaust at specific fume producing equipment. The exhaust will be tied into the ventilation exhaust systems. Depending on the toxicity of the exhaust fumes, Bubble Tight dampers equivalent to the units listed above for the science lab exhaust system will be utilized to isolate the toxic fumes from the rest of the exhaust system during a unit shutdown. The exhaust system will be designed to satisfy the CHPS 2.0 requirements.

New dust collection systems including dust collectors and ductwork with manual isolation dampers will be installed in the Design/Tech room, the Woodshop and the Autobody shop. The dust collectors will be equivalent to Dust Gorilla Pro system with HEPA filtration, cyclone separator, integral collection bin, unit stand, filter gauge and bin fill level indicator.



There will be multiple ERV/HRV units and duct systems that will be utilized to condition the (4) main educational buildings on campus. The ventilation units will be located as close to the center of the zone that they serve as possible to minimize ductwork. See SD rooftop equipment drawing for approximate preliminary unit locations. The preliminary ventilation systems, sizes, and the locations they serve are indicated below:

A-building:

ERV-1A (existing to remain unit located in Level 4 mechanical room): This ERV is an existing unit rated for a nominal 10,000 CFM. The ERV will be repurposed to serve different spaces as part of the renovation project. This ERV will serve the Level 1 rooms from the Band Room and Chorus Room east including the Ensemble and practice rooms, the Level 2 Team Rooms, Locker Rooms, Fitness Room. The current unit has a hot water coil and split system Direct Expansion (DX) cooling system with a rooftop condensing unit. The existing hot water coil, DX coil and rooftop condensing unit will remain. The existing roof mounted louvered penthouse for the ERV exhaust will need to be relocated. The ductwork will need to be revised to accommodate the revised unit exhaust location.

ERV-2A (Petra Unit): This ERV will be rated for a nominal 17,000 CFM and will serve the Cafeteria, Kitchen and back-of-house cooking spaces, the Culinary Arts Kitchen, Culinary Arts Café, The Level 3 Councilor Offices, the Health Services offices, the Level 3 Main Entry area, the Level 4 I.S.N Offices, the I.T. Offices, and the Level 4 Mezzanine area. This unit will require smoke dampers along with a return duct smoke detector. The unit is to be located on the roof of the Cafeteria with roof mounted ductwork (insulated with 3" of 6 PCF fiberglass insulation wrapped in an EPDM membrane) suspended above the roof on rooftop duct supports equivalent to Miro Industries Model# 10-DS. Outdoor Air and Exhaust Air ductwork shall run across the Cafeteria roof and rise up in the southeast corner of that roof up the vertical wall of the A-building to the roof of the A-building and shall drop back down into Level 4 ceiling space. Insulated isolation dampers (equivalent to Ruskin TED50) are to be located at the duct penetration of the roof deck. This unit is to operate with a 2,000 CFM offset (more supply than exhaust) when the kitchen hoods are in operation.

HRV-1A: This HRV will be rated for a nominal 20,000 CFM. This unit will have supply and return air duct smoke detector(s) and supply and exhaust smoke dampers equal to the dampers indicated for the rooftop air handling units. The unit will serve Spray Booth 1042 on Level 1. A large exhaust air filter rack is to be installed at the back (east) end of the space and supply air is to be discharge at the front (west) end of the space. The unit is to be suspended in the ceiling of the Aviation space along the southern wall. The unit is to be equivalent to an Xetex XHS with a heat exchanger core, MERV 8 filters on the supply and exhaust before the heat exchanger core, and 4" MERV 13 final filters. The unit will have a gas-fired indirect heat exchanger with a modulating burner. This unit is to have explosion proof fans and shall be spark resistant.

HRV-2A: This HRV will be rated for a nominal 18,000 CFM. The unit will serve the BTC spaces at the western end of the A-building. The unit will be located on the roof above the Level 4 Art Rooms and will serve the Level 1 Auto Body shop and surrounding support spaces, the Level 2 Aviation shop and surrounding support spaces, the Aviation classrooms, and the Property Services (facilities) offices and support spaces, the Level 3 Wood Shop and surrounding support spaces, the Design/Tech room, the BTC Faculty rooms, and the Level 4 Art Rooms. The airflow will be controlled via Variable Air Volume (VAV) boxes and the unit supply and



exhaust fans will operate as a variable volume unit to maintain a duct static pressure set point. This unit will have the epoxy coating indicated above. This unit will have supply and return duct smoke detectors as well as smoke dampers, equal to Ruskin SD-60 with flanged frame and linkage as required with 24VAC actuators and UL listed for smoke control. Discharge supply air will be conditioned by the air-source heat pump remote condensing unit and heating hot water coil sized to provide neutral air temperatures.

B-building:

ERV-1B: This ERV will be rated for a nominal 13,500 CFM and will serve the classrooms and spaces west of the building's central stairwell. The unit will be installed on the roof approximately in the middle of the area served. This unit will also ventilate the connector to the D-building including the (4) classrooms in the connector addition.

ERV-2B: This ERV will be rated for a nominal 16,000 CFM and will serve the classrooms and spaces east of the building's central stairwell including the lower level library and administrative spaces. The unit will be installed on the roof approximately in the middle of the B-building addition.

F-building (Tech Center):

ERV-1F (Tech Center F-building): This ERV will be rated for a nominal 9,000 CFM and will serve all spaces in the F-building that are not served by the HRV's. See HRV scheduling below for spaces served by the HRV's. This unit will be located on the roof near the middle of the building.

HRV-1F: This HRV will be rated for a nominal 5,500 CFM and will be located on the roof near the southern end of the Building. This unit will serve the Level 1 Auto Tech shop and surrounding support spaces, the Level 1 BTC classroom Aviation shop, and the Level 1 Toilet/Shower area.

HRV-2F: This unit will be rated for a nominal 7,000 CFM and will be located on the roof near the northern end of the building. This unit will serve the Level 2 Metal/Welding shop and surround support spaces, the Metals Shop and the surround support spaces, the Welding Classroom, and the Pre-Tech/Makers Space and the surrounding support spaces.

Mechanical-Central Plant Design

The campus will be heated by both the existing to remain biomass heating plant and new natural gas fired boilers that will be located in the existing G-building. Operation of the natural gas fired boilers and the biomass plant will be by the Direct Digital Controls (DDC) system. All circulator pumps will be either base mounted (aligned from the factory) or inline type with high efficiency variable speed EC motors. Larger inline circulator pumps will be vertical type.

The central heating hot water system will operate as a primary-secondary pumping system with the existing biomass boiler tying into the new primary campus heating loop for heat add, as will the new gas fired boilers located within the G-building when the loop drops below set point. The heating hot water plant consists of the existing biomass plant and a proposed high efficiency natural gas boiler plant which will be located at the existing biomass plant facility. The proposed natural gas heating plant will be based on (3) Riello Array 4000 (AR 4000) boilers which each have a net output capacity of 3,844,000 BTU/Hr and a 40:1 turn down ratio. The new boilers will



be sealed combustion type with fully ducted intake combustion air (ducted from the outside) and fully ducted exhaust flues. Each boiler will be a multi/modular burner type with each burner containing an individual (dedicated) circulator. Two (2) of the boilers will be utilized to heat the central primary heating hot water loop during the shoulder seasons and as backup heating for the biomass plant. The third boiler will initially be the primary heating source for the existing to remain E-building and will also provide heating hot water to the D-building and F-building through a 500 gallon buffer tank equivalent to A.O. Smith TJV-500 ASME. The boiler will also have the ability to heat the primary heating hot water loop. A secondary heating hot water system will be piped to the D-building, F-building, and tie into the existing E-building heating loop (see secondary heating hot water system below). This secondary system will be glycolated until the E-building is demolished; a heat exchanger with circulator pumps will use the primary heating system to condition the buffer tank. The secondary system serving the D, F, and E-buildings will pump water through the buffer tank. There will be (3) redundant heating hot water circulators will be rated for 200 GPM at 80 feet of head to distribute hot water to the D, F, and E-building.

Heating Hot Water Primary System

The primary heating hot water piping will distribute water from the (2) central plants to each of the buildings by the primary heating hot water circulator pumps. The primary heating hot water loop will be circulated by (2) pumps operating simultaneously with a third pump for redundancy. The proposed pumps are to be rated for 700 GPM at 50 feet of head each. Each building shall have a mechanical room to serve the secondary pumps and piping systems. The primary piping system will run underground from the main boiler plant to the D-building and will rise up inside the northern exterior wall to the roof. The underground piping will be pre-insulated PEX (cross-linked polyethylene with oxygen barrier). A branch will run to the D-building mechanical room. The primary loop piping will rise up to the roof of D-building and will run in a “doghouse” (the doghouse will continue the roof insulation over the heating hot water piping) on the roof of D-building (preliminary estimates are for approximately 180 feet of rooftop doghouse on D-building). A branch will run along the roof of D-building in a “doghouse” to the F-building and will penetrate the F-building exterior wall (above the D-building to F-building connector) and will run to the F-building mechanical room. The primary heating hot water will then run across the roof from the D-building and the D to B-building connector (preliminary estimates are for approximately 105 feet of rooftop doghouse on D to B-building connector) and will drop down at the southern end of the connector. A branch will run across the roof of B-building in a “doghouse” (preliminary estimates are for approximately 20 feet of rooftop doghouse on B-building) and drop down into the B-building mechanical room. The primary piping will drop down from the B-building and into the ceiling space of the cafeteria in A-building. The primary loop piping will rise up in A-building to get into the Level 4 A-building ceiling space and will run to the A-building mechanical room.

The primary loop piping will utilize a modulating control valve to inject the primary loop water into the secondary heating hot water systems to maintain the secondary loop temperatures at set point.

Heating Hot Water Secondary System

All heating hot water secondary circulator pumps will modulate their speed to maintain a differential pressure set point between the heating hot water supply and heating hot water return piping.



The D-building will have a single secondary piping system served by (2) redundant variable volume circulators. The circulators will be rated for 190 GPM at 50 feet of head.

The F-building will have a single secondary piping system served by (2) redundant variable volume circulators. The proposed pumps will be rated for 300 GPM at 60 feet of head.

The B-building will have a single secondary piping system served by (2) redundant variable volume circulators. The proposed pumps will be rated for 280 GPM at 60 feet of head.

The A-building will have (4) secondary piping systems, each served by (2) redundant variable volume circulators. The circulator pumps will modulate their speed to maintain a differential pressure set point between the heating hot water supply and return piping in each system. The circulator pump systems are to be served by (2) redundant variable volume circulators with ratings of 250 GPM, 390 GPM, 225 GPM, and 350 GPM.

Temporary Heating Hot Water Tie-in

During the temporary operation of the E-building, a new heating hot water line will run from the G-building to the existing E-building. The piping will be run exposed (outdoors) with 2" of elastomeric foam insulation (equivalent to Armacell or Aerocel) with UV coating and aluminum jacketing. The heating hot water system is to be filled with a 40% propylene glycol solution while the system is serving the temporary E-building. Provide a new Axiom Industries DMF300 glycol feeder for the hydronic system. Once E-building has been demolished, the system will be drained and filled with treated water.

Domestic Hot Water

The domestic hot water for the D-building will be supplied by a new Rheem PROPH80 T2 RH350 DCB 80 gallon hybrid heat pump water heater. A stainless steel lead free circulator pump will be installed to recirculate domestic hot water through a dedicated Domestic Hot Water Recirculation (DHWR) system.

The domestic hot water for the F-building will be supplied by a new Rheem PROPH80 T2 RH350 DCB 80 gallon hybrid heat pump water heater. A stainless steel lead free circulator pump will be installed to recirculate domestic hot water through a dedicated Domestic Hot Water Recirculation (DHWR) system.

The domestic hot water for the A-building and B-building will be supplied by (2) 119 gallon A.O. Smith MXi water heaters. The water heaters are to be models BTH-400A rated for 400,000 Btu./hr. each. Multiple stainless steel lead free circulator pumps will be installed to recirculate domestic hot water through dedicated Domestic Hot Water Recirculation (DHWR) systems. A separate system will be installed for the B-building, the A-building cooking facilities, and the remainder of the A-building for a total of (3) separate DHWR systems.

Athletic Field Concessions Stand Conditioning (To be included as an Add-Alternate)

The existing athletic field concessions stand is currently conditioned using a propane fired heater. We recommend replacing this heater with an air-to-air heat pump system. The air-source heat pump is to be equivalent to Samsung DVM S Eco AM060MXMDCH/AA rated for a nominal 60,000 btu/hr. cooling and a nominal 66,000 btu/hr. heating. The conditioned air will be distributed to the space via wall mounted or suspended heat pump indoor units, models AM0xxMNVDCHAA and AM0xxMNHDCCHAA respectively.



Controls

A Direct Digital Controls (DDC) system will be utilized to provide proper control and monitoring of all the new HVAC equipment. The DDC system will be web based enabling remote access and will utilize the BACnet protocol. This system will be capable of managing energy savings functions of the mechanical systems and also provide alarms to building manager/service team. The building automation system shall include the following functionality:

- Each independent HVAC zone shall be configured with (1) combination temperature, relative humidity, and CO2 sensor with digital display and the ability to control zone temperature set point.
- Each independent space in the building shall be configured with a wall mounted temperature sensor.
- Each space will be configured with occupancy sensors (from the lighting controls system) which will utilize connect to the lighting controls system to monitor the occupancy sensors in each space
- The natural gas and biomass heating plant controls shall operate in conjunction to maintain space temperature set points in all spaces. Controls to ensure that systems are not operate in conflict with each other
- Ventilation system shall be configured as a variable volume system based on space occupancy and CO2 levels.
- Ventilation systems serving localized exhaust (which ties into the HRV exhaust system with VAV's)
- Air-Source VRF heat pump systems will have BACnet interconnectivity such that the DDC system can monitor the operation of the heat pumps and adjust space set points, lockout the compressor system at a specified outdoor air temperature, and operate the hot water reheat control valves.
- Heat pump systems (both VRF and rooftop units) shall tie into the Automatic Transfer Switch (ATS) so that when a power outage is detected, the system shall load shed by disabling approximately 2/3 of the campus heat pumps and the non-essential ventilation units before then sending a signal that the ATS may switch over to generator power.

Typical Energy Recovery/Air Handling Unit Controls Points

DI	Supply Fan Status	DO	Supply Fan Enable
DI	Supply Fan Status	DO	Supply Fan Enable
DI	Exhaust Fan Status	DO	Exhaust Fan Enable
DI	Exhaust Fan Status	DO	Exhaust Fan Enable
DI	Energy Wheel Status	DO	Energy Wheel Enable
DI	Freeze Stat Trip Status	DO	Refrigeration System Enable
DI	Refrigeration System Alarm Status	DO	Dehumidification Enable
DI	Refrigeration	DO	Supply Isolation

	System Status		Damper Open/Close
DI	Supply Air Duct Detector	DO	Exhaust Isolation Damper Open/Close
DI	Exhaust Air Duct Detector	DO	Unit Outdoor Air Isolation Damper Open/Close
DI	Supply Smoke Damper Status	DO	Unit Exhaust Air Isolation Damper Open/Close
DI	Exhaust Smoke Damper Status	DO	Heat Trace Relay Enable
DI	Supply Air Isolation Damper Status		
DI	Exhaust Air Isolation Damper Status	AO	Supply Fan Speed Control
DI	Unit Outdoor Air Damper Status	AO	Supply Fan Speed Control
DI	Unit Relief Air Damper Status	AO	Exhaust Fan Speed Control
		AO	Refrigeration System Discharge Temp. Set Point
AI	Supply Air Temperature	AO	Energy Wheel Speed Control
AI	Supply Air Relative Humidity	AO	Wheel Bypass Damper Modulation
AI	Post Wheel Outdoor Air Temperature	AO	Hot Water Heating Valve Modulation
AI	Post Wheel Outdoor Relative Humidity		
AI	Post DX Coil Temperature	AI	Exhaust Air Static Pressure
AI	Exhaust Air Temperature	AI	Supply Fan Speed Feedback
AI	Exhaust Air Relative Humidity	AI	Supply Fan Speed Feedback
AI	Spare	AI	Exhaust Fan Speed Feedback
AI	Spare	AI	Exhaust Fan Speed Feedback



AI	Outdoor Air Pre-Filter DP	AI	Energy Wheel Speed Feedback
AI	Exhaust Air Pre-Filter DP	AI	Bypass Damper Position
AI	Final Filter DP	AI	Internal Cabinet Temperature
AI	Supply Air Static Pressure		

HVAC Ductwork and Piping Materials

Refrigerant piping shall be Type L (ACR) copper with brazed joints and fittings. All piping shall be insulated per the 2020 Vermont Commercial Energy Code.

Heating hot water piping shall be Type L copper with soldered joints and fittings for 2" and smaller. Piping shall be Schedule 40 welded steel for piping 2 1/2" and larger. An alternate price shall be provided to use Aquatherm blue (Polypropylene-R) piping and electro-fusion welded joints and fittings. Heating water piping shall be insulated per the 2020 Vermont Commercial Energy Code.

Building Conditioning, Kitchen Make-up Air System and Building Ventilation Systems ductwork materials shall be G-90 galvanized steel. All ductwork shall be insulated per the 2020 Vermont Commercial Energy Code.

The HVAC air distribution systems (fan coil units, kitchen make-up air unit, and ventilation system) shall be fully ducted, including all supply and return/exhaust air ductwork. The air distribution systems shall be designed in accordance with the recommended practices of ASHRAE, Chapter 21, "Duct Design", 2013 "Fundamentals" Handbook and SMACNA "HVAC Duct System Design". Supply and return ductwork shall be designed to maintain an air velocity below 800 FPM near duct transitions and take-offs and below 500 FPM near terminal units to minimize noise levels.

All discharge, and return air ducts supporting diffusers and registers shall be fitted with adjustable locking quadrant type volume dampers to allow balancing and adjustment of air flows into each room. Dampers shall be located at takeoffs from main air ducts to minimize noise at registers.

Flexible air ducting shall be limited to 6 feet total length per take-off. All distribution ductwork shall be sealed to a Class B seal.

All penetrations through fire rated shaft partitions shall be fitted with fire dampers, access doors, and breakaway connections as required.

All concealed ductwork shall be insulated per the 2020 Vermont Commercial Energy Code.

The HVAC systems sound levels shall meet the following sound criteria: Less than 35 dB (A) at any location 2'-0" from noise source, air outlet or equipment.



Grease Laden Vapor Exhaust ductwork materials shall be fully welded type 304 Stainless Steel with cleanouts as required per NFPA 96. The ductwork shall be insulated with 3" fire wrap.

The Grease Laden Vapor Exhaust system, including but not limited to duct material, duct velocities, duct construction, installation of owner furnished canopy hood, clearances, and equipment listings, shall be designed and installed per the requirements of all local, state and federal codes and standards including but not limited to the International Building Code and NFPA 96.

6. Plumbing

Existing Fixture Reuse

Provide a deduct alternate price to remove (and safely store) and reinstall the existing plumbing fixtures in the main/central public restrooms in A-building Level 3. L.N. Consulting does not recommend retaining these fixtures since the ceilings will be removed to work on the HVAC systems and all of the plumbing piping will be replaced which will likely require the fixtures to be removed and stored during the demolition phase.

The recently renovated restrooms in A-building Level 4 (north end) are to be reused. These fixtures may require removal during construction (pricing should include removal and safe storage during construction) since the HVAC systems will be replaced in this area.

Sanitary Waste and Vent System

Waste and venting piping shall be installed per the latest adopted edition of the International Plumbing Code. We recommend replacing the entire waste and vent piping system for the A, B, and D-buildings. Waste exit locations from each building are to be coordinated with the Civil Engineer. We recommend replacing the entire waste and vent piping system within the F-building as the main restrooms are being relocated and all of the fixtures are being replaced.

Roof Drains

The building roofs shall be supported by new roof drains as required to meet the guidelines of the 2018 International Plumbing Code. The storm drainage system shall exit separately from the sanitary drainage system. Roof drains shall be insulated per the 2018 Vermont Commercial Energy Code.

Grease Waste and Vent System

The building grease waste system will be supported from a new 4" grease waste main and an exterior grease trap located on site (location to be coordinated with Civil Engineer). Final grease trap sizing to be determined once the kitchen design is completed. Fixtures in the cooking kitchen that contain grease waste shall discharge to the grease waste system through indirect drains (floor sinks) where required per code.

Fixtures

All fixtures shall comply with Vermont's Anti-Lead law VT ACT 193 (0.25% weighted average lead content for fixtures). We recommend using low flow or dual flush water closets and low flow urinals for water conservation purposes with automatic sensor controlled flush valves. The lavatories will be based upon low flow, automatically controlled faucets for water conservation and infection control purposes. The janitors closets should be fitted with floor mounted 24"x24" basins with utility faucet, mop holder, wall guards, and bucket hose. Water fountains (where



applicable) should be based upon a standard ADA wall mounted unit that is fitted with a carbon filter system and water bottle filler.

All plumbing fixtures in the A, B, D and F-buildings are to be replaced with new.

Water Supply Systems and Domestic Water System

A new domestic water entrance (and fire protection service) shall be installed in the A-building to support both the A and B-buildings. A new domestic water service entrance (and fire protection service) shall be installed in the F-building to support both the F and D-buildings. A 3" domestic cold water entrance shall tap off of the main fire protection entrance in the A-building to support the A and B-buildings. A new 2 ½" domestic cold water entrance shall tap off of the main fire protection entrance in the F-building to support the F and D-buildings. The water entrances shall each have a backflow preventer, water meter, pressure reducing valve, pressure gauges, and isolation valves.

Domestic Hot Water System

As noted above, the domestic hot water for the A and B buildings will be via (2) 120 gallon natural gas fired water heaters. Final sizing will be determined once a fixture count has been finalized.

D-Building domestic hot water heater and backflow preventer to be replaced with a new 80 Gallon Hybrid Heat Pump water heater equivalent to Rheem PROPH80 T2 RH350 DCB as indicated above. The D-building domestic hot and cold water distribution systems are to be completely replaced to service the new plumbing fixtures. Final sizing will be determined once a fixture count has been finalized.

F-Building domestic hot water heater and backflow preventer to be replaced with a new 80 Gallon Hybrid Heat Pump water heater equivalent to Rheem PROPH80 T2 RH350 DCB as indicated above. The F-building domestic hot and cold water distribution systems are to be completely replaced to service the new plumbing fixtures. Final sizing will be determined once a fixture count has been finalized.

The domestic hot water systems shall be configured with main mixing valves located at the domestic hot water heaters to maintain the hot water supply temperature below 120°F. There shall also be mixing valves located at the public lavatory faucets to provide tempered hot water to those fixtures. A domestic hot water recirculation (DHWR) system will be installed as indicated above. There will be multiple recirculation systems serving the A and B-buildings as indicated above. The D-building will have a dedicated DHWR system and the F-building will have a dedicated DHWR system. Balance valves (Lead Free) will be installed on each branch of the system to ensure each branch is receiving adequate flow. The DHWR systems shall be configured to provide a recirculating connection within 2'-0" of each commercial lavatory. The DHWR systems will be controlled by temperature sensor(s) and building occupancy sensor(s) along with timeclock control.

Natural Gas System

Natural gas piping for the A-building will be provided for the cooking appliances, natural gas fired unit heater in the spray booth, the heat recovery ventilation unit (HRV-1A) that serves the spray booth, and make-up air units MAU-1 and MAU-2. A main service entrance with a low pressure regulator will be installed for the new natural gas piping system for the kitchen. A separate natural gas entrance and meter will be installed for the unit heater and HRV-1A



serving the paint spray booth. The natural gas service entrance location will be coordinated with the Civil Engineer. Piping shall be sized and installed per NFPA 54 for low pressure drop.

Natural gas piping for the D-building will be provided for the science labs. A new natural gas service entrance location will be coordinated with the Civil Engineer. Piping shall be sized and installed per NFPA 54 for low pressure drop.

Each science lab will be provided with an Emergency Power Off (EPO) button to shut down both the power and close an emergency natural gas valve to stop the gas supply to the lab.

Plumbing Piping Materials

DCW piping shall be Type L copper with soldered joints and fittings or Aquatherm green (Polypropylene-R) piping and electro-fusion welded joints and fittings. DCW piping shall be insulated per the 2020 Vermont Commercial Energy Code.

DHW and DHWR piping shall be Type L copper with soldered joints and fittings or Aquatherm green (Polypropylene-R) piping and electro-fusion welded joints and fittings. DHW and DHWR piping shall be insulated per the 2020 Vermont Commercial Energy Code.

Sanitary waste and vent piping shall be schedule 40 PVC piping for both above and below ground piping.

Storm drainage piping shall be schedule 40 PVC piping for both above and below ground piping.

All grease waste and vent piping shall be schedule 40 PVC piping from the fixture to the exterior grease trap.

Above ground natural gas piping shall be Schedule 40 ASTM A 53 Steel Pipe, Type E or S, Grade B, Black.

7. Electrical

Distribution

The existing electrical distribution system within the school is made up of a combination of some newer panelboards and circuits that have been added since the school was built and a significant amount of equipment that is original equipment. The school was originally designed to accommodate electric heat, however due to the removal of essentially all the electric heat the service entrance was reduced. Due to the proposed addition to the school, and the implementation of air conditioning, the service will need to be significantly expanded. See drawings E3 through E5 for the existing electrical distribution system with proposed demolition, and drawings E6 and E7 for the proposed new electrical service and infrastructure.

The entire electrical infrastructure of the Building A, B, D and F will be replaced with a new code compliant electrical system that meets the program requirements for each space. The proposed main service entrance will be relocated to the new location, tentatively shown on the western side of Level 1 in the A-building. This service will serve buildings A, B, D and F, as well as the Pump House (Bldg. G). Refer to drawing E2 for proposed main electric room layout.



To accommodate the additions to the facility, our preliminary estimate is that a service size of 3000 amps, 277/480 volts, three phase, four wire would be required. This service will require ground fault protection at the main breaker within the main distribution switchboard. It will be fed from a new Burlington Electric Department (BED) pad mount transformer located externally and to west of Aviation room. The final location of the main electric room is being determined. All 277/480 volt and below electrical work to be by Owner's contractors at Owner's expense. All high voltage underground or overhead circuit work shall be done by BED at Owner's expense, other than the transformer vault and conduits to a BED pole which will be provided by the Owner's contractor at the Owner's expense. The vault shall be per BED standards for large transformer vaults.

To accommodate distances, it is proposed to provide a new electric room for four (4) quadrants of the new Building A; Southwest (SW), Southeast (SE), Northeast (NE) and Northwest (NW). A new fifth electric room will be provided in Building F to serve that building. The SW electric room is actually the Main Electric Room which will include the 3500 amp service entrance switchgear. The other three electric rooms will be approximately 8'x8'. From each of these electric rooms, all panelboards, elevators, HVAC equipment, etc., within that quadrant will be fed. Additional panelboards, typically 100 amp or 225 amp main lug only type, will be located throughout the "quadrant" in small "closets". These panelboards will typically serve most 20 amp circuits for classroom, office and corridor receptacles and lighting, as well as specific panelboards provided for locations such as kitchens, shops, mechanical spaces, etc.

The fault current rating of all 480 volt panelboards and switchboards in the main electric room shall be 35,000 amps or more. The fault current rating of all 208 volt panelboards in the main electric room shall be 42,000 amps or more. The fault current ratings for the other electric rooms shall be minimum 25,000 amps for 480 volt and 22,000 amps for 208 volt panelboards. For the most part all remaining 480 volt panelboards will be rated for 14,000 amps and 208 volt panelboards for 10,000 amps.

The existing electrical service to Building E will remain as is and the Woodchip Plant would remain fed from Building E. The existing Building G (Pump House) will be removed from the Building E electrical system and tied into the new electrical distribution system for Building A.

The main switchboards or panelboards on both the 480 volt and 208 volt systems, within each of the "main" quadrant electric rooms, will be provided with surge protection. Additionally, the main 480 switchboard for the entire campus will be provided with an integral power meter to monitor energy usage and power quality.

Within each electric room, a 480 volt to 120/208 volt, three-phase, four-wire step-down transformer will be provided for 120 and 208 volt loads. The intent is to keep the number of transformers to a minimum. Where feasible, transformers will only be located within the four quadrant electric rooms.

It is expected all large HVAC equipment will be fed from one of the main distribution panels. The kitchen to be provided with dedicated 225 amp panelboards to accommodate the significant amount of equipment, and depending on the number of hoods a separate panelboard for shunt-trip loads may also be provided. These panels will also serve smaller HVAC and refrigeration loads. Depending on space, locations for these panelboards will need to be verified to conform to ADA standards.



Each science lab, Aviation shop, Auto Body shop, Metal shop, Design/Tech space, and Library Maker Space will each be provided with an Emergency Power Off (EPO) switch to enable power to be cut to the space in case of an emergency. Each lab or similar space where dangerous tools are not used will be provided with a dedicated relay panel that will shut off power to receptacles or other devices and close any gas valves. EPO's will be located in multiple locations within each space for added safety. For shops and other locations where dangerous equipment is used, each room will be provided with a dedicated panelboard with a main shunt trip breaker or contactor. See attached drawing E1 for typical installation in labs.

Depending on whether the elevators are hydraulic or machine room-less will dictate the size of these circuits and where they are fed from. Per Vermont codes the elevators shall not be provided with shunt trip operation. Assume each elevator 40 horsepower at 480 volts three phase, fed via 110 amp circuit breaker and circuit.

The proposed design does not include a standby power emergency generator. If a generator was to be added as part of an alternate to the base design, it would be tied into the main electric service entrance room at southwest corner of Building A via a 3000 amp automatic transfer switch (ATS). To keep the size of the generator to a minimum, the Building Management System (BMS) would be used to shut-down all non-necessary equipment during a power outage. The ATS would be inhibited from transferring to the generator until a signal is sent by the BMS that all non-essential equipment has been shut-down. The final selection of equipment to be shut-down would be determined. The proposed size of the generator would be 500kW/625kVA.

The electrical distribution will be designed to accommodate alternative energy solutions. The building currently has photovoltaics installed on the roof, and the new electrical system will be designed for this system and for the installation of additional photovoltaics or other alternative energy systems. This will include providing spare breakers in the main electrical gear and running spare conduits from the BED transformer to the main electric room or where the alternative energy source is located. Additional conduits will also be run, via chases or shafts, up to the roof from the main electric room.

Included with this report are proposed electrical distribution one-lines for the project (drawings E6 and E7). These are very preliminary and do not show all devices such as shunt-trip panels, connections to large HVAC equipment, final panelboard sizes, etc. The final number of panelboards may change, however the drawings do provide a fundamental idea of the proposed basis of design.

Branch Circuiting

The majority of the branch circuiting will be concealed in spaces such as ceilings and walls. In concealed areas, armored MC or AC cable may be used.

For exposed circuiting, EMT conduit is to be used where approved by electrical codes. For corrosive areas Schedule 40 PVC conduit to be used. Rigid steel conduit only used in areas subject to physical damage where required by electrical codes. Schedule 40 PVC conduit to be used for underground circuits.



In some locations, the use of Wiremold will be used, particularly where flexibility of device locations is desired. Where only receptacles or only data required, Wiremold 2000 Series steel raceway to be used. Where both receptacles and data required, Wiremold 4000 Series steel raceway to be used.

Where running circuits to exterior locations, smaller surge protective devices will be provided at the panelboard or breaker serving these circuits.

For feeders over 100 amps, aluminum conductors will be used. For elevators or larger HVAC equipment, aluminum may be used up to the contractor-furnished disconnect switch however copper conductors shall be used between disconnect and unit.

Lighting

New LED light fixtures would be used throughout the facility. All existing lighting within Building A, B, D and F will be removed. Other than in rooms such as closets, mechanical rooms, or other minimally occupied spaces, dimming will be provided. Dimming can significantly reduce electrical consumption as fixtures can be dimmed to provide only the amount of lighting the specific occupant requires. The dimming function is also useful in locations with exterior exposure; daylight harvesting control can dim rows of fixtures as daylight enters through exterior glazing. LNC recommends installing pendant mounted direct/indirect lighting for all classrooms, including labs, in the facility. Where pendant mounted fixtures are not feasible, recessed 2x2 fixtures with a direct/indirect style of illumination is proposed. Refer to attached drawing E1 for typical lighting layouts and fixture information.

For corridors and similar spaces with grid tile ceilings, 2x2 lighting would typically be used, except in special circumstances, and spaced approximately 10' on center for ceilings below 9' and 12' on center for ceilings 9' and above. These 2x2 fixtures will be similar to those shown on drawing E1.

For small bathrooms a 24" vanity wall mount direct/indirect LED fixture above mirror will be provided. For larger multi-person bathrooms, a row of direct/indirect wall mount light fixtures will be provided above mirrors at sinks and above the toilets along the opposite wall. Fixtures proposed to be Litecontrol MOD 3 3L-W-IAD-SPA-2' or 4'-SOF-C1-40K-I100/D050-D01-1C-UNV or equal. Large restrooms controlled via occupancy sensor for auto on/auto off, with local keyed switch for maintenance. Small, single person restrooms provided with manual on/auto off control and occupancy sensor.

For gymnasiums the design foot candle level will be approximately 75. It is estimated lighting will be located approximately 22' AFF, spaced 15' on center, Fixtures proposed to be 2'x4' high-bay LED type with wireguards (Columbia Pelaton P4-40-MXHE-FA-ED-WG type or equal). Some fixtures to be fed via a lighting inverter for emergency power. Provide with dimming capability. Control of lighting to be via wall-mount occupancy sensors, keyed switches and programmed operation (manual or via "scenes") via networked lighting control system.

Stairwells will be provided with wall mount direct/indirect on wall along stair risers. These fixtures to be provided with integral battery backup. Control of these fixtures, including occupancy sensors to allow lights to dim when stairwell not occupied, will be tied to the network. Fixtures proposed to be Columbia ESL-4-40-ML-FA-W-ED-U-ELL14-NXOS or equal.



A new lighting technology that is becoming more prevalent is the ability to “tune” or alter the color temperature of the fixtures. Although studies are still being done, this may have an effect on circadian and behavioral responses by students by varying the lighting color temperature with the time of the day or for a specific class. The lighting color temperature can be reduced to a warmer light in areas to provide aid in providing a calmer atmosphere, while cooler color temperature lighting can be used to provide for better illumination for more visual tasks. Where deemed appropriate, the use of color tuning lighting would be implemented. It is expected there will be very minimal use of color tuning on this project.

All lighting shall be DLC or EnergyStar rated, where applicable. Emergency interior lighting will be typically via exit signs with integral “eyeball” emergency lighting. Where additional emergency lighting required, wall mounted “eyeball” type fixtures will be provided. In large spaces with high ceilings such as gymnasiums or auditoriums, the use of a lighting inverter that powers select ceiling mounted lighting in the space will be used. All emergency lighting will be battery backup type with self-diagnostics.

All exterior exit locations shall be provided with egress lighting. This will be a combination of building mounted lighting, as well as pole mounted lighting. Emergency power would be provided via several lighting inverters located indoors to provide power to the exterior building mounted fixtures within the entire campus. Exterior building mounted lighting to be Hubbell LNC2-12LU-4K-3-1 for mounting heights below 12’ AFG and LNC2-18LU-4K-3-1 for heights above 12’, or equal, and will be controlled via network lighting control system based on local outdoor-rated occupancy sensors and ambient light levels.

Site lighting design is part of the landscape scope, however it is assumed pole lighting will be 20’ or less in height. All pole lighting to be provided with wireless lighting control that is compatible with the networked lighting control system.

Unless directed by others, all lighting foot candle levels will be based on latest edition of the IESNA (Illuminating Engineering Society of North American) design handbook.

With all lighting being replaced, the lighting system will be fed via the 277/480 volt system to reduce infrastructure costs, transformer sizes and electric losses.

Lighting Controls

The new lighting control system will be a digital type system, similar to Acuity nLight Digital Network control system. Lighting shall be controlled in zones. The system shall be provided with a network backbone for web-based remote access from any authorized computer. The system will be able to provide both control and monitoring of the entire lighting system within the building. It also provides the Owner with an easier method to program, as well as providing the Commissioning agent a better way of performing final programming. Although the technology and costs are changing, it is expected a wired system may be more practical due to the scope of renovation work. Due to the scale of this project, there may be a desire to “network” the other school lighting control systems within the school district to allow access from a single connection.

For lighting furnished with freezers, coolers, etc., the intent is to provide power to the lighting via the control system to allow for control and monitoring of light fixtures.



The exterior lighting will also be tied into the control system to enable remote timeclock and occupancy control. The pole or other remote lighting will be controlled via wireless “mesh” networks to the main lighting control system. The exterior lighting including site lighting will also be dimmable.

The lighting control system will have the means to estimate lighting load via algorithms within the software based on fixture type, level of dimming, etc.

Lighting for individual rooms will be provided with local control. All spaces shall be provided with occupancy sensors. Where required by energy code, daylight harvesting control will be provided. Egress paths, large restrooms, electrical and mechanical spaces will be auto on/auto off. Non-egress paths will generally be manual on/auto off, with exceptions as required for safety. See attached drawing E1 for typical control layouts for rooms with multiple zones.

The lighting control system will tie into the BMS via BACnet or other similar means. Status, alarm and control ability from the BMS will be feasible, including means to turn lights on via fire alarm or security alarm activation.

See drawing E10 for proposed lighting control detail drawings.

General Power

Provide commercial specification grade 120 volt NEMA 5-20R receptacles as follows:

- See attached drawing E1 for some typical room receptacle layouts.
- All 20 amp non-locking receptacles in gymnasiums and auditoriums shall be tamper-resistant.
- (1) Receptacle every 25' along walls in corridors.
- Coordination will be required for locations such as shop and science classrooms to ensure adequate power and receptacles. Provide “non-standard” receptacles as needed.
- General-use GFCI receptacles in kitchen, prep areas, service areas, in addition to receptacles indicated on kitchen vendor plans. Locate every 20' along walls.
- Assume (4) power circuits for each server room(s). Assume at least (1) 30 amp circuit.
- Several receptacles for small data closet(s), mechanical and electrical rooms, and exterior locations. Each data closet, mechanical and electric room will be on a dedicated circuit.
- Four (4) new construction classrooms each to be provided with floor boxes with (2) duplex receptacles each (also (2) data jacks each). (1) Classroom on Level 4, (1) classroom on Level 5, (1) classroom on Level 1 of B-D connector and (1) classroom on Level 2 of B-D connector.

The intent will be to keep the number of 20 amp receptacles per circuit to less than 6. Some locations may be less depending on requirements.

Where required by energy code or other ordinances, some receptacles will be tied into the lighting control system for load shedding when areas are not occupied. This is expected to be minimal.



Kitchen, prep areas, etc., designed by others shall be provided with receptacles and power as indicated on kitchen equipment vendor supplied drawings.

All single phase receptacles less than 150 volts to ground up to 50 amps and 208/240 volt three phase receptacles up to 100 amps in kitchens, bathrooms, within 6' of sinks, wet locations indoors or outdoors, locker rooms, garages and service bays, or other similar rooms, shall be provided with GFCI protection. Where GFCI protection is not "readily accessible" (i.e., behind dishwasher, etc.), the GFCI protection shall be provided with the circuit breakers in panelboards or the use of "blank face" devices with GFCI test buttons located adjacent to receptacle and in an accessible location.

In some locations such as common/waiting areas, classrooms and Labs, receptacles with USB ports will be provided.

Coordinate with mechanical contractor and mechanical controls contractor for all power for HVAC and plumbing equipment. Intent is to locate as much equipment on the 480 volt system as possible. All controls including 120 volt power for control systems to be provided under mechanical work. All VFDs or other motor control equipment to be provided under mechanical work.

Fire Alarm

As part of any reconstruction the entire fire alarm system and infrastructure would be replaced and a new addressable fire alarm system with full voice evacuation that complies with local, state and NFPA requirements be installed. System shall be Mircom FX2000 or equal as approved by Owner. The fire alarm would tie into the security and lighting control systems for enhanced safety. Manual pull stations at each exit and at stairwells will be provided. At locations open to the public, protective covers (such as STI Stopper II) to be provided on pull stations.

This upgrade may impact Building E where no work is planned. This includes some possible replacement or retrofit of existing devices. It is assumed Building E would be tied into the new fire alarm system via modules to tie the older system into the new.

Smoke detectors to be provided only in a few areas, such as storage rooms or other rooms where normally not occupied, and corridors. Duct smoke detectors to be provided in supply ductwork for all HVAC equipment with a supply CFM of 2,000 or higher and in the return ductwork where return CFM is 15,000 or greater. Locate detectors per manufacturer's standards and prior to branching of ductwork.

Magnetic door hold-opens will be provided at all classroom, office, etc., doors with closers. Additional smoke detectors are not required at each of these doors.

The fire alarm system will have connections to fire protection systems such as, but not limited to, the sprinkler and kitchen suppression systems.

It is understood a fire pump is not required.

Provide smoke detectors at each elevator lobby and each elevator machine room.



At no location within the building will the decibel level for the fire alarm system be less than 75 dBA.

“Panic buttons” will be provided where required to send alarm to fire or police department as well as release door hold-opens.

The fire alarm will communicate with the local fire department via radio call box per City of Burlington, Vermont standards.

See attached drawing E9 for additional information.

Telecommunications

Reuse of the existing data/phone infrastructure is impractical and replacement of all data circuits is recommended. The older phone lines would be removed entirely and the use of VOIP phones recommended. The existing IT equipment would be reviewed as to whether it could be reused. It is recommended the school district’s IT department start to develop a plan for how a new telecommunication infrastructure should be designed.

Due to the size of the campus and limits to telecom cable lengths, it is proposed to provide data closets throughout Building A similarly to how the electric rooms are being laid out. The telecom conduit(s) would enter the building the same way the electrical does; via the spray booth room within concrete encased conduit. Due to phasing, the new main IT server room and area will not be completed as part of the initial phase work. It is proposed that the room where the telecom service enters building, shown on drawing E2 adjacent to the main electric room, to act as a temporary “main server” space until the final IT and Server room area is completed. The temporary main server room will then become one of the data closets. An additional data closet would be provided for Building B, D and F. Each of these data closets would tie back into a main telecom room via fiber cable. See attached drawing E8.

For Building E, a new conduit would be run from the new building to the Building E existing main telecom room to tie to the school’s main infrastructure.

Contractor shall run CAT6 data cable and terminate at patch panels and CAT6 jacks. Each office or workstation to be provided with (2) RJ-45 jacks in single outlet box. Each jack shall be provided with a dedicated CAT6 cable. All cables and terminations shall be tested per telecom standards.

Provide ceiling mounted data jacks for wireless access ports. Estimate (1) jack every 50’ square (2,500 sf) per floor.

At a minimum provide (1) data jacks for fire alarm panel, (2) data jacks for BMS system, (2) data jacks for each elevator, (2) data jacks for networked lighting control, (2) data jacks for security system, (1) data jack for electronic meter in main 480 volt switchboard.

Kitchen, prep areas, etc., designed by others shall be provided with data and voice jacks as indicated on kitchen equipment vendor supplied drawings. At a minimum, (2) data jacks shall be provided in each location.



In the (4) new classrooms described in the General Power section above, floor boxes with (2) duplex receptacles and (2) data jacks will be provided. Also in classrooms a data jack for a ceiling mounted projector and a data jack on wall for monitor will be provided.

Miscellaneous

The existing security system vendor should also be contacted to determine what, if any, existing equipment can be utilized as part of a building reconstruction. It is expected the existing cabling infrastructure and all devices would be replaced due to it being impractical to attempt to reuse them. The security system would tie into the BMS system. Means to perform functions such as automatic lockdown, lighting control, monitoring by remote means (police department, etc.) would be provided. Security cameras will be located throughout the campus, both indoors and outdoors

The school will be provided with a new public address system throughout.

The existing auditorium lighting systems are to remain as is. The electrical infrastructure (wiring, panelboards, devices, etc.) will be replaced. Any new sound systems or stage lighting to be part of add alternate package.

Within classrooms, meeting rooms or other like locations where TV monitors or similar may be used, a recessed wall mounted 3-gang box with 1.25" conduit with pull string up to ceiling space will be provided to provide for future A/V cable access to monitor. A duplex receptacle and data jack will also be provided.

8. Fire Protection

A new fire protection entrance located in A-building shall be 8" (hydrant flow test is required to verify entrance size and system pipe sizing) and sized to provide a complete NFPA 13 compliant fire protection system for the A and B-buildings. A new 4" fire protection entrance shall be located in F-building (hydrant flow test required to verify entrance size and system pipe size) and sized to provide a complete NFPA 13 compliant fire protection system for the F and D-buildings. The fire protection system shall be designed by a NICET Level III Technician experienced in design of this type of work and licensed in Vermont. The majority of the building shall be covered as Light Hazard density with 0.1 GPM/sq.ft over 1500 sq.ft with some locations such as storage rooms, mechanical rooms, shops and kitchens shall be covered under Ordinary Hazard Group 1 density with 0.15 GPM/sq.ft over 1500 sq.ft. An Ansul fire suppression system shall be installed under the hoods in both kitchens to provide fire protection against grease and cooking fires. Provide dry-type sidewall sprinkler heads to protect exterior canopies.

Fire protection piping shall be threaded-end schedule 40 steel for 1-½" and below. Fire protection piping 2" shall be schedule 40 or schedule 10 steel with grooved fittings.

Please feel free to ask us any questions regarding this scope of work.

Sincerely,

Ian Donahue
John Askew



George Martin
Aaron Welch

L.N. Consulting, Inc.